INDEX TO ADVERTISERS AND CONTENTS ON PAGE 30.

THE FOUNDRY

VOL. 17. DETROIT, MICH., NOVEMBER, 1900 No 99.

PUBLISHED MONTHLY BY
THE FOUNDRY PUBLISHING CO.
DETROIT, MICH.

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SUBSCRIPTION PRICE:

$1.00 a year in advance, postage prepaid in the United States, Canada and Mexico.
$1.75 a year to other countries, postage prepaid.
Single Copies, 15 Cents.

ADVERTISING RATES ARE PRINTED IN EACH ISSUE

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We can not furnish a continuous set of back numbers beyond August, 1900.

Entered at the Post Office at Detroit, Mich., as second-class matter.

The Flux Fakirs' Latest.

A gang of swindlers, who have been driven from the United States to Mexico, largely through the efforts of THE FOUNDRY and the exposition of their fraudulent methods in these columns, have recently been trying to have some fun with themselves by sending through the mails a slip which it is intended should reflect upon the proprietor of this publication.

Were the matter worthy of notice it might merit the attention of the officers of the law, but as it can not be regarded as being otherwise than a compliment to the paper that has so successfully exposed the swindlers upon several occasions, we are sure this latest brilliant idea will not hurt anyone but those who have originated it.

Trade Outlook.

As far as the pig iron market is concerned there is no change to be recorded since our last issue. While this country is not producing at the maximum rate, it should still be satisfactory to know that trade has not by any means reached a point where it may be considered dull or inactive. Much work remains to be done; improvements are badly needed in many quarters. By many the approaching election is held accountable for the slackening in demand, but in this connection it should be noted that the downward tendency exists not only here but also in Great Britain and on the continent.

Rogers, Brown & Co. recently said: "The improvement before noted has been well maintained, and the orders entered aggregate a good tonnage and comprehend every variety of domestic production. Inquiries are liberal and afford a tonic for the opening or the market. Prices are very irregular and depend largely upon the views of the producers as to what the selling prices should be. The condition of the furnace order books and the stocks in the furnace yards determine the action of most producers. During the past fortnight many more furnaces have been obliged to consider blowing out, as prices current are below cost of manufacture, and cost can not be reduced except by deep cuts in raw material and reduction of wages. It is an open question whether any one would be benefited by such reductions, as the margin sought for is almost invariably given away by the consumers. There is good reason to believe that the improvement in domestic demand will be augmented steadily throughout the fall, as the old stocks in the hands of consumers are being steadily and rapidly reduced."

Matthey Addy & Co. comment as follows: "While there is a brisk buying movement, it is hard to find anything of particular note in the iron market at present. The buying is of the same kind that has been going on for six weeks. That is, sales are mainly

confined to small lots for quick shipment. The volume of trade of this kind has been steadily growing. As regards prices there is still, as there has been now for months, great diversity of opinion on the part of the iron masters. In Southern irons particularly there is no uniformity of price and differences of a dollar on the same grade are for from uncommon. It seems, however, that as a rule bottom has been touched. The makers of Northern irons tell us that at present they have no profit. And in the South by reason of the great increase in cost we hear the same thing. So the furnaces have come to the place where they must make a final stand or in many instances give up the fight altogether. It is conceded on all hands that the result of the election will have a great influence on the situation."

Some Ideas of To-Day.

It is now generally conceded that a manufacturing concern can invest a portion of its capital in things which are not strictly necessary to the operation of the plant, and do so with a fair chance of receiving back full interest thereon.

It is coming to be recognized that a contented workman is much more productive than one who has legitimate excuse for growling. Thoroughly ventilated and well heated foundries will turn out more castings than some of the cold barns the majority of us are acquainted with.

A workman's physical comfort has a great deal to do with his output. Let the rate of wages be identical, the shop which provides the best quarters and conditions attracts the best class of labor.

We are continually in receipt of inquiries as to what others are accomplishing in their attempt to make their factories more than a place for working. Several of these relate to the cost of providing a shop's crew with their midday meal.

When a shop is located in a small village its occupants can usually find living quarters in its immediate vicinity. A few minutes will take them to their homes and the discomforts of a cold dinner are known to but few.

With the manufacturing interests located in large cities this question assumes another phase, and that several are trying to provide their workmen with a warm dinner at actual cost shows that there is need for something in this direction.

The shortest route to the good-will of a workman is through his stomach. In this respect he is something like a poor sinner. We do not believe that prayer meetings in a foundry amount to much. These are out of both place and time there. The outer man is what demands attention.

As far as we have been able to ascertain no foundry has so far made the experiment of providing its molders with their noonday meal. Other factories have, however, and as results have demonstrated that this plan is not only possible but also self-sustaining, if not of ultimate profit, within a certain degree, to the shop owner, we will condense some of the information we have on the subject into the following lines.

At the National Cash Register Company's plant at Dayton, Ohio, the female employes receive a warm lunch free of charge, to which each can add whatever her fancy dictates. The company says that in more ways than one is it reimbursed for this outlay. Greater promptness on the part of the employe and more careful attention to work on their part than before the system was begun is calculated in dollars and cents to have more than made up for the expenses incurred.

The Cleveland Twist Drill Company of Cleveland, Ohio, has for quite a while furnished its employes with a lunch at noontime and the following details concerning its methods of dealing with the problem may be of interest.

The Cleveland Twist Drill Company determined, after observing the greater part of their employes eating cold lunches in odd places around the works, that something should be done to improve these conditions. After a great deal of thought on the subject, it arrived at the conclusion that if it could furnish its workmen with a warm, well-cooked and neatly served dinner at a small cost, that it in turn would receive better returns from this labor in the shop through increased efficiency, and that besides this the men would be more contented and likely enjoy better health.

To carry out the plan a dining room and kitchen were fitted out at the works. The former contains three tables each 82 feet long, together having a seating capacity of 260 men at a time. The tables are covered

with white oilcloth and each seat is numbered so that everyone knows his place from day to day.

The men are divided into squads of eight and from these is selected one who acts as waiter for a term of two weeks, when another takes his place, and so on until all have served in this capacity, when the first man again assumes this duty. Each waiter is furnished with an apron and tray, the former having three pockets intended for the reception of meal checks. These are made from hard rubber of different colors, readily distinguishable, and are of one, two and five-cent denominations. They are for sale by the timekeeper only and can be purchased from him in lots of from twenty-five cents upward.

The menu for the following day, together with the price of each article, is displayed in the dining room during meal time, and before leaving same the men fill out an order card as shown for the next day's dinner, giving same to the waiter, together with the necessary checks to pay for what has been ordered. This card the waiter leaves with the chef, who is thus fully informed as to the quantity of each article it will be necessary to provide. By this plan there can be but little food wasted.

EAST.—Section No. .....

	Total	1	2	3	4	5	6	7	8	9	10
Soup,											
Roast,											
Sausage,											
Wiener-Wurst,											
Hamburg,											
Pork and Beans,											
Potatoes,											
Corn,											
Cabbage,											
Sauer Kraut											
Tomatoes,											
Turnips,											
Parsnips,											
Meat Sandwich,											
Butter											
Cheese											
Coffee,											
Tea											
Dessert,											

ORDER CARD.

The waiters, of whom there are thirty, assemble in the dining room fifteen minutes before the dinner hour arrives, the company donating this time. Forming in line at the kitchen counter the waiter calls off his orders from the cards filled out the day before and pays for same with the checks he then received. By the time the whistle blows the tables are ready, promptness being necessary, as the employes have but half an hour rest at noontime in this establishment.

The kitchen is equipped with a large double-oven hotel range and all the conveniences found in a first-class restaurant. The chef has one permanent assistant and during meal time two men from the shipping department assist the kitchen force in serving.

It has been the aim of the Cleveland Twist Drill Company to only charge the men the exact cost of the food. No attempt has been made to include the cost of the equipment nor the salaries paid the chef and his assistants. All of this and the waiters' time is donated by the company. Everything is bought in large quantities and the men given the benefit of so doing. The menu is changed daily in order to afford variety.

SAMPLE MENU.

Pea soup	1c.
Roast lamb	3c.
Stewed tomatoes	1c.
Mashed potatoes	1c.
Ham sandwich	2c.
Cheese sandwich	2c.
Bread pudding	2c.
Mince pie	3c.
Coffee	1c.
Tea	1c.
Ginger snaps, five for	1c.
Crackers, five for	1c.

The Cleveland Twist Drill Company say their efforts have been thoroughly appreciated by their men, and that results have proven very satisfactory. It is a daily occurrence to have mechanics apply for work at this factory who say that they prefer to work for a company who takes some interest in the welfare of its workmen.

The Cleveland Hardware Company of Cleveland, Ohio, also provides a warm lunch for its men at noontime and follow very nearly the same plan as the Cleveland Twist Drill Company. Owing to a lack of room the former concern has not been able to give as large quarters to this purpose as is desired. Instead of a dining room, the lunches

are delivered to the men in the shop, about eight lunches being handled in specially arranged box-like fixtures with shelves, which keep the food clean and warm until wanted.

This company, too, expresses itself as being remibursed for its trouble and outlay and intends to still further increase its efforts in this direction as soon as circumstances will allow them. Both of these concerns are doing something which others should also find to their advantage to carry out. Labor is not such an unresponsive element that it will receive added comforts without attempting to offer something in return. H.

Care of Tools.

BY L. C. JEWETT.

I recently visited a foundry where I saw such a reckless exhibition of disregard for tools as to cause me to write a few lines on this subject.

Most shops supply their molders with tools and the latter should certainly take every care to preserve them as long as possible. They should not be left where clamps, chunks of pig iron and flasks could injure them by falling on them or be thrown in their direction.

Of course we all know that the average foundryman takes but small pains to provide a place for tools, and many times is himself inidrectly to blame for the short time they last.

Several foundrymen have tried the experiment of opening a tool account with every molder, and where private lockers are provided in which the molder can with safety leave his tools and be sure that no one will disturb them, the plan works well. Such a custom is not a hardship to those who are careful and there is no doubt but that it has a restraining influence upon the thoughtless.

By furnishing every molder a complete outfit of tools and a place to keep them, the frequent disputes as to ownership would cease and it would also prevent the haggling and brawls which are now occurring in foundries where there is no system of any kind.

I once worked at a small foundry in a western city where there were very exacting rules and regulations about coming to work in the morning and about dropping the cupola bottom at night (not dangerosuly early before 6 p. m.); in fact, the whole shop was blessed with intricate formalities galore. But when it came to providing tools these in numbers fell much short of the regulations. About six or eight rammers and the same number of riddles were made to do duty for a dozen and sometimes more molders.

To cap the small number of tools of all descriptions furnished by this particular foundry, there was but one particular way by which moisture could be applied to any part of the shop, and this was through the medium of a large, custom-made and warranted, copper watering pot. It certainly was a splendid specimen of the coppersmith's art and a credit to its makers.

On each floor, of course, the sand had to be tempered every morning and the molder who for the first time secured the privilege of using this copper watering outfit would certainly realize that in this shop at least there was some work about the job of tempering sand. Its contents could not be thrown on the sand as with a bucket, but time had to be taken to permit it to leak through in the regular course. About the time one got his sand pile ready he began to sigh for Saturday night. Tugs of war were common to decide who had the right of way in using this clumsy and heavy watering pot, more than one black eye resulted from disputes of this kind, and it was a cold morning that did not show up some diversion of this kind.

It may be asked why this shop should be stingy about its tools and why it should furnish such clumsy and unhandy things as this watering pot. I learned that these were the direct results of the careless and wanton destruction of innumerable wooden and zinc water pails and the general indifference as to care upon the part of the molders which all tools had received. It seems that upon learning of the short lives of ordinary water buckets the proprietor had taken an oath that if something decent to hold water could not live in that foundry that he would provide somthing that would, and I never knew a promise which was more religiously kept.

The proprietor was a lawyer by profession and reputed to be a most excellent one at that, but the clumsy tools he furnished fixed his rating as a foundryman away down below zero by the molders. For all of which

the latter gentlemen had largely themselves to blame, as if they had shown some inclination to take care of what was given them, they would have continued to receive the kind with which they should have been provided. In being niggardly the owner was of course injuring his own interests; yet is it not human nature to buck contrariness, especially when it appears to be exhibited by a set of workmen more in a spirit of deviltry than anything else?

Krank's Korner.

The other day I ran across an article describing in detail the molding of a flywheel through the use of a sweep to form the rim and cores to make the arms.

* * *

This method of making flywheels is as old as the hills, and I would not refer to it here but for the fact that illustrations showed the arm cores bolted together at an expense of time and matedial that is quite unnecessary.

* * *

I remember one foundry where the coremakers used to paste the arm cores together and then put half a dozen bands of strong wire around each core. This, too, is not needed.

* * *

The neatest way is to take the arm cores as they come from the core box, in halves, and locate them where wanted. Then place the top half of the cores and clamp the whole together; ordinary foundry clamps will do.

* * *

There are a lot of things done in the foundry by the longest route it is possible to make out. In the majority of instances the shortest is just as safe, if not more so.

* * *

There is a certain amount of thickheadedness to be found among both employers and employes. Sometimes both sides will attempt to do what a little common sense should show them is entirely unreasonable.

* * *

A short time ago in a certain steel foundry a molder was told to make a certain casting. The pattern had a number of loose pieces, and, as is sometimes the case where no system of marking prevails some of these pieces would fit in more than one position. After the casting had been made it was discovered that it was worthless through one of these being misplaced.

Now begins the queer part of a lawsuit. The company, whose molders all worked day work, proceeded to charge Mr. Molder up with the full value of the casting, charging him, if I remember rightly, about ten cents a pound. The whole thing amounted to nearly fifty dollars, but as Mr. Molder only had a little over two weeks' pay coming to him and lacked a few dollars of having this amount due him, the company, to show its good nature, was willing to call the account even.

* * *

Let us now use a little common sense. In the first place all the loss the company could possibly claim would be the material wasted in making the mold and the cost of melting the metal, together with the value of the molder's time while engaged on this job. Instead of confining itself to a legitimate loss the company wanted a fancy price for the lost casting, and were then not even willing that the molder should have the scrap he had made.

* * *

Having hired this molder to work by the day, a little sound, gold standard reasoning on the part of the company should have told it that its position was entirely untenable. It had only itself to blame for making or accepting patterns on which it was possible to shift loose pieces. Granting that the molder in question was not a first-class workman, it had only itself to blame for having hired him. Having hired him by the day without mentioning that he should be responsible for lost castings, the company was liable for his day's wages as long as it retained him. At least, that is the way things look to me.

* * *

Let us suppose that this same concern had hired this molder to work and agreed to pay him on the piece-work plan. Could the company by any possible amount of reasoning jolly itself into the belief that it would have a right to charge the workman for more than his time? Suppose an employer should sue an employe for not being a competent workman, what would the decision be? It is a risk which every employer assumes in hiring anyone to work for him.

* * *

That it should have been necessary in this case for the Iron Molders' Union of North America to come to the assistance of

this molder before he could obtain his just dues from his employers plainly demonstrates that some of the latter are as much in need of education as some of the ignorant molders they employ.

Two Ways of Doing the Same Job.

BY HENRY O'NEIL.

It is not uncommon to hear people say "our" castings cost too much. Those who are loudest in that cry are almost invariably imbued with the notion that the ignorance or indifference of the molder is accountable for the desperate condition of the foundry. These people seem to be graduates from the same school, and to have exhausted their mental energy on negation and become rutty on executive ability, with little sense of what to execute. In many foundries in twenty-nine States I have closely observed these people, and I find that most of the ridicule and censure heaped upon the molder is shifted from its rightful bearing. Few, indeed, are the cases where the molder can do otherwise than pursue the course prescribed by those who would "lay him off" if he showed a disposition to advance in practice beyond their obsolete ideas.

To produce castings at minimum cost, and up to the purpose, is the object of all foundries, yet the materials and methods adopted by many could not be better calculated to not do it. Here the caliber of the foreman or manager is easily taken, and a sagacious man can readily discern if the existence of a foundry is due to its manager or to favorable surrounding conditions. In many industrial plants the relation of pattern shop, foundry, and machine shop is not strictly recognized, and each is run at considerable disadvantage to the others. The pattern shop often turns out patterns which

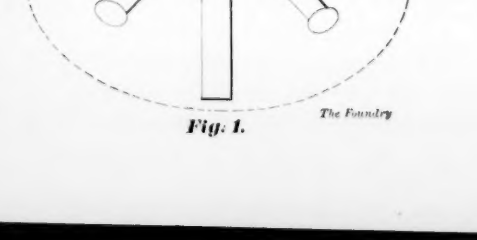


Fig. 1.

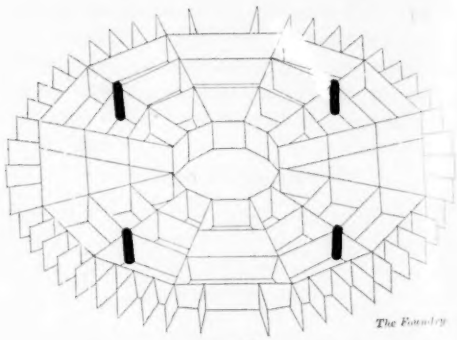


Fig. 2.

involve the foundry in needless expenditure of time in molding; the foundry often supplies the machine shop with castings of grossly distorted shape, and in the machine shop time is often charged back to the foundry which could be avoided. The day is not very distant when the successful man must be able to free himself from conventionalities, look upon what has been done without being mentally warped, and in the balance of theory and practice weigh present and contemplated methods without waiving consideration of any item related to the problem, for the conditions of nature are rigid, and neglect of an item may result in disaster and prove the calculation false.

With a few sketches I will try to give an idea of two of the many ways that different men have dealt with the problem of making the common fly-wheel. The difference in favor of one method is more than three to one in both foundry and pattern shop. One is the method of men who know there is something required of foundrymen beside managing men. The other is the method of those people whose brains have become corroded on executive ability, and in the industrial race they are not direct in their course.

In Fig. 1 I will try to give a perspective view of the pattern required, and a part of the process of making a wheel by some people's method. It is the worst I have seen. In Fig. 3 I will try to also give a perspective view of the best method I have seen. It will be noticed that the difference in pattern making required is the difference in

making the core-box (Fig. 4) and one-half of hub (Fig. 5), or making all of the arms and the whole hub. Now, let us consider what the molder will do when he gets the awkward accumulation of patterns as per Fig. 1. He must first set up the hub and arms on the sweep-shaft, then he must ram

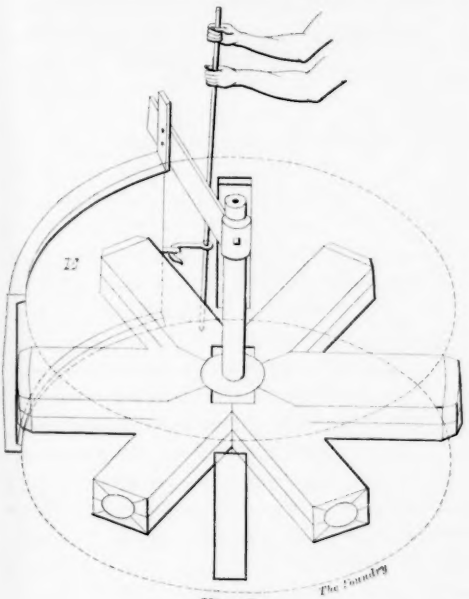


Fig. 3.

up the under side of each arm separately; when all the arms have been rammed under, the parting must be made as shown at P; then the cast-iron lifter (Fig. 2)—which was not made for a song—must be placed on the parting and the torturing process of securing and ramming over each arm separately must be continued until the circle is complete, with sweep X the required dimensions are obtained. When the arms are taken out and top part of mold returned to its position the rim segment B must be placed against the completed part of mold and the outside rammed up and joint made, when the segment is drawn up and moved ahead and rammed until the outside is complete.

I will not impose on the reader's attention with a description of the manner of holding the mold down for any way will hold it as well as the other.

To make a wheel as per Fig. 3, the bottom half of hub core is located on the sweep shaft and the sand swept off even with its top face. The arm cores are located and top half of hub core placed, and sand rammed to the required height to within a foot or two from the rim. Next the surface for bottom of rim is swept up and segment E secured to sweep arm, and both inside and outside of rim rammed at the same time and joint made. The segment is moved ahead by means of a bar applied as shown. I have purposely spared the reader all par-

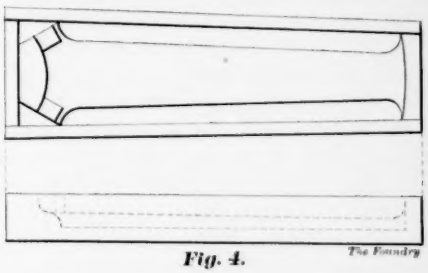


Fig. 4.

ticulars about securing, venting, and the like, for my purpose is only to show the two methods of making wheels. I have heard foundrymen who "have been at the business for years, and ought to know about it," declare "that's all right theoretically, but you couldn't make a casting that way. You'd have a nice time getting that rim pattern out after the circle was complete." However, in the last twenty years many wheels from six to twenty feet diameter have been made by this method, which was originated to make castings for a man who knew better than to buy a needless lot of

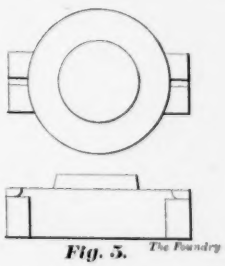


Fig. 5.

iron which would cost him money to convert into chips. The pattern is taken out at one of the drawbacks, which are necessary to get at the rim-lugs. It makes a difference where the pattern is located on the circle when ramming is commenced, else the wise (?) man would prove his declaration true.

Of all the awkward practice to be seen in different foundries I have taken a simple fly-wheel for an illustration, because it is so generally seen in foundries.

Cupola Fuels.

In these days of advancement in foundry practice, the subject of cupola fuel is frequently referred to in several scientific papers, and inquiries in regard to the use of various fuels are frequently made, with a view of reducing the cost of fuel, and doing more economical melting.

Coke, when of good quality, is undoubtedly the best cupola fuel. With it, iron may be melted rapidly and of any degree of heat desired, for the work to be cast. It therefore possesses or gives the two requisites of modern foundry practice: rapid melting and hot fluid iron. But all coals do not make good cupola coke, and foundries located at a great distance from the foundry coke centers frequently find that the cost of transportation makes their coke very expensive, and as the saying is, "costs its weight in gold."

These are the founders who are looking for a cheaper and better cupola fuel. The latter, we fear, will be hard to find, but the former may be had, and a few recollections of melting done, when cupola fuels were not so perfect as to-day and of experiments made with various fuels may be of interest.

GAS AND LIQUID FUEL.

The question is frequently asked: Why cannot iron be melted in a cupola for foundry work with gas, such as natural gas, illuminating gas; or liquid fuel, such as petroleum, oil, benzine, gasoline, etc., more economically than with coal or coke?

The reason these fuels cannot be used in a cupola is that the cupola furnace is constructed upon the principle of melting iron in direct contact with the fuel consumed in melting it.

Iron, when first reduced from a solid to a molten state in a cupola, is not sufficiently fluid to flow into a mold, and must be superheated and made more fluid than when first melted, before it can be used for foundry work. And a cupola fuel must be of a sufficient density to support the iron while melting and to superheat it to a sufficient extent, before dropping to the bottom of the cupola to run the work to be cast.

The gas and liquid fuel possess sufficient heat producing units to melt iron in a cupola, but they are deficient in the requisite supporting properties of a cupola fuel. And iron, when melted by them, drops as soon as melted to the bottom of the cupola, where it cannot be superheated or at least has not been superheated by any plan yet devised.

The writer, like many others, conceived the idea of melting iron in a cupola with these fuels many years ago. And in 1878 laid his plans for doing so before Mr. John S. Perry and Mr. Andrew Dickey, of the Perry Stove Co., two of the most advanced men in foundry practice at that time in this country.

They thought the plan feasible and offered me every facility at their foundry plant, at Sing Sing, N. Y., for melting iron with any of these fuels I might select.

A small cupola was constructed with numerous small openings or tuyeres, through which a blow pipe flame could be thrown upon the iron. At each of these openings a lamp filled with kerosene oil was placed and the flame from the burner directed upon the iron by means of blow pipes connected with a main blast pipe, supplied by a fan blower.

By this means it was hoped to melt iron as rapidly in a 12 or 18 inch cupola, as it could be melted in a 60-inch cupola with anthracite coal.

For the first test a bed of coal was put in up to the first row of tuyers to support the iron and keep it off the sand bottom. When the coal was well burned iron was charged and the numerous blow pipe flames were directed upon it through the tuyers. The iron was readily melted in this test by the blow pipe flames, but was not sufficiently fluid when drawn from the tap hole to be cast.

To overcome this difficulty the melting zone which had only been about one foot in depth was increased to four feet and an increased number of blow pipe flames directed upon the iron. This caused the iron to be melted more rapidly, but did not increase its temperature or make it more fluid, but rather decreased its fluidity. For the rapid melting increased the body of molten iron passing through the bed of coal, causing it to pass through more rapidly and it was not superheated by the bed to the same extent, as when the melting was not so rapid.

After a number of failures in this line to produce a hot iron it was decided to aban-

don the lamps, and convert the oil into gas with a view of getting a hotter flame.

A retort was cast and after being properly connected with the cupola was charged with crude petroleum oil, and the flame from the gas generated directed upon the iron by means of the blow pipes as before, throughout a four foot melting zone.

This plan melted the iron rapidly, but like the other, failed to produce a hot fluid iron.

A bed of coal was then placed in the cupola and a light blast put on for the purpose of superheating the iron, after being melted with the gas. This plan produced a hot fluid iron, but after superheating a limited amount of iron the bed became exhausted and the only way to replenish it was to draw off all the iron, shut off the gas and put in a new bed.

The fresh bed had to be heated and the temperature of the melting zone brought up to the melting point before melting could be resumed. This resulted in considerable loss of time and waste of fuel in melting and was not considered practical.

The blow pipe theory was then abandoned and a series of pipes placed in the melting zone, for the purpose of superheating the gas, before burning it and creating a more intense heat than we had yet obtained.

This plan melted the iron, but as before failed to produce a hot fluid iron, and the pipes in a short time became so choked with carbon that the gas failed to pass through them, and melting stopped. This difficulty could have been overcome to a sufficient extent to prevent the formation of carbon in them, but the iron melted was not satisfactory and this plan was abandoned.

After these repeated failures Mr. Perry, Mr. Dickey and their entire foundry staff were consulted as to how a hot iron could be obtained in melting with these fuels, and a number of plans suggested by them were tried, all of which proved failures. And it was decided that a hot fluid iron could not be melted in a cupola with these fuels, no matter how hot the melting zone might be made. For the reason that the iron when melted dropped through the melting zone so rapidly that it could not be superheated.

Since these experiments I have been called upon several times to assist in devising a plan to melt iron in a cupola with these fuels, and have learned of other experiments having been made, all of which proved failures. And so far as I know, iron has never been melted in a cupola sufficiently hot and fluid for general foundry work with any of the gases or liquid fuels.

Iron may be melted for foundry work with these fuels in furnaces especially designed for their use.

Brass and other metals may also be melted with them, in a properly constructed furnace for using them.

One of the latest and most successful experimenters in designing and constructing furnaces for the melting of metals with oils and gases is W. J. Brown, Philadelphia, Pa., and founders favorably located for using such fuels may gain further information on the subject by addressing Mr. Brown.

CHARCOAL FUEL.

The first fuel that was used in this country in smelting iron from its ores and also in cupola practice was charcoal, and for many years it was the only fuel available for these purposes. It produced a superior iron in many respects to that obtained with fuels in general use at the present time, but with the increase in population and disappearance of the forest, charcoal is no longer available for this purpose; except in mountainous districts where land is worthless for any other purpose than the growing of timber, or in thinly populated districts where the forests have not yet been destroyed.

Such districts are generally located a long distance from the cupola fuel centers and a few points on cupola practice with charcoal fuel may be of interest to foundrymen situated in those localities, and also to others who are unable to get a satisfactory iron with other fuel.

My experience in melting with this fuel in cupolas has been limited to small cupolas of from 20 to 30 inches inside diameter. But the fuel will carry as heavy a burden in a cupola as in a blast furnace, and is therefore available in melting in any sized cupola up to that of a charcoal blast furnace, which will include the largest cupolas now employed in the melting of iron for foundry work.

When melting with charcoal the fuel and iron are placed in the cupola in charges, in the same manner as when melting with coal or coke. A sufficient quantity of shavings,

straw, or other combustible material to ignite the fuel are first placed in the cupola. Upon this a layer of small soft wood and upon this a bed of charcoal extending to from 18 to 20 inches above top of tuyeres. Upon this a charge of iron is placed and upon the iron a charge of charcoal, and upon this a charge of iron and so on until the entire heat to be melted is placed in the cupola.

As charcoal is light and readily combustible it is customary to fill the cupola with stock before lighting the fire, and to avoid wasting the fuel, to put on the blast as soon as the charcoal has become ignited and there is a good fire in it at the tuyeres.

Charcoal does not carry as heavy a burden as coal or coke and the charges of iron are made lighter and more numerous than when melting with these fuels.

The weight of charges of fuel and iron are varied to suit the volume of blast which should be lighter than when melting with the harder and less freely combustible fuels.

The charges of fuel are made about 6 inches in depth or thickness and the largest amount of iron which can be melted at a charge is the amount that can be melted without reducing the bed to such an extent that the next charge of fuel will not replenish the bed and bring it up to the top of the melting zone for melting the next charge.

When charges of fuel and iron are properly proportioned iron may be melted sufficiently hot to run the lightest of castings at a ratio of from 3 to 4 pounds of iron to a pound of fuel.

It has been found in furnace practice that the best charcoals for fuel are made from the hard woods, and from small timber rather than from the large, and the second and third growth small hard timber makes a charcoal that will carry a heavier burden and last longer than charcoal from first growth timber.

Small cedar timber makes a very good fuel charcoal, and is the principal wood used for this purpose in some sections of the south.

There are sections of this country where more economical melting can no doubt be done with charcoal than with coal or coke, but the results obtained when melting with charcoal are not to be compared to those obtained with either of the above fuels, when fast melting and hot iron is desired.

Philadelphia, Pa. DR. EDWARD KIRK.

Two Cheap Rigs.

By H. Fisher.

In reading the story of a small job in the May issue of THE FOUNDRY, the same made me think of a couple of jobs with which I was at various times connected. One of these was made in the far west, the other in the east. The former job was a blow-off for a water pipe line, and is illustrated in Fig. 1.

While this job may be considered a very small one in some of our eastern shops, still with the prices they were paying for material, at Portland, Ore., together with high wages, and the east to compete against, it took considerable thought to turn this job out in such a manner as to make it pay. We made these castings in green sand, inside and out, our method being about as follows:

We put the spindle center about four feet, two inches below the floor line, and after putting in the cinder bed, we swept up a level bed of sand about three feet eight inches below the floor line. As there were about forty of these castings to make we resorted to the use of a full pattern, leaving the bottom bell and nozzle portion of the pattern loose.

We had a hole made through the pattern a little larger than the diameter of the spindle, around which we fitted a cast iron plate about the diameter of the spindle. (A, Fig. 1). This was made as shown, so that if it did not exactly fit as cast it could easily be filed out to save machine work. The hole in the bottom plate for the core was made in the same way; our pattern was then placed on the bed and rammed up to center. In bedding the nozzle portion of the pattern in we had a center line on the main part of the pattern, and by placing one-half of the nozzle portion in line with this and leveling the other end we were sure of it being in the right position.

As any molder knows by looking at the illustration we would have to make a drawback for this nozzle, and for this purpose I made an iron box, as shown at B, in a position ready to be rammed up, C being the end view. As this box ran to a feather edge where it came against the pattern, we

made no joint, and this also did away with staking, as it will be noticed that the box has sufficient draft to obviate this. After we had our parting made at the half of the nozzle we simply put our box on and rammed the mold up inside and up to the top of the main pattern, after which the mold was ready for the cope.

As our spindle was still in position we had to leave a hole in the center of the cope for this to pass through. After our cope was rammed up, lifted off, and finished, we drew our main pattern, while leaving the spindle in its original position, which helped to steady the pattern. We then took our spindle out to give us room to get into the mold and finish same, our draw-back being lifted off by means of three holes cast in the box, as shown in D, E, F.

Our next job was to make the core, and it was here again that the services of the spindle came in handy. We had our bottom board made with a plug in the center the same size as the spindle and about four inches long, on which we placed the bottom plate for the core, the latter having a hole to fit this plug, and also three nuts cast in same for lifting hooks, H. Besides this we also cast two rings to keep the core from spreading or the hooks from cracking the core while being lifted into the mold. The grooves at J, K, only permitted a clearance of one-eighth inch from the body of the mold, while the core was being lowered into place. Hence it will easily be seen where the spindle came in handy in helping to set same.

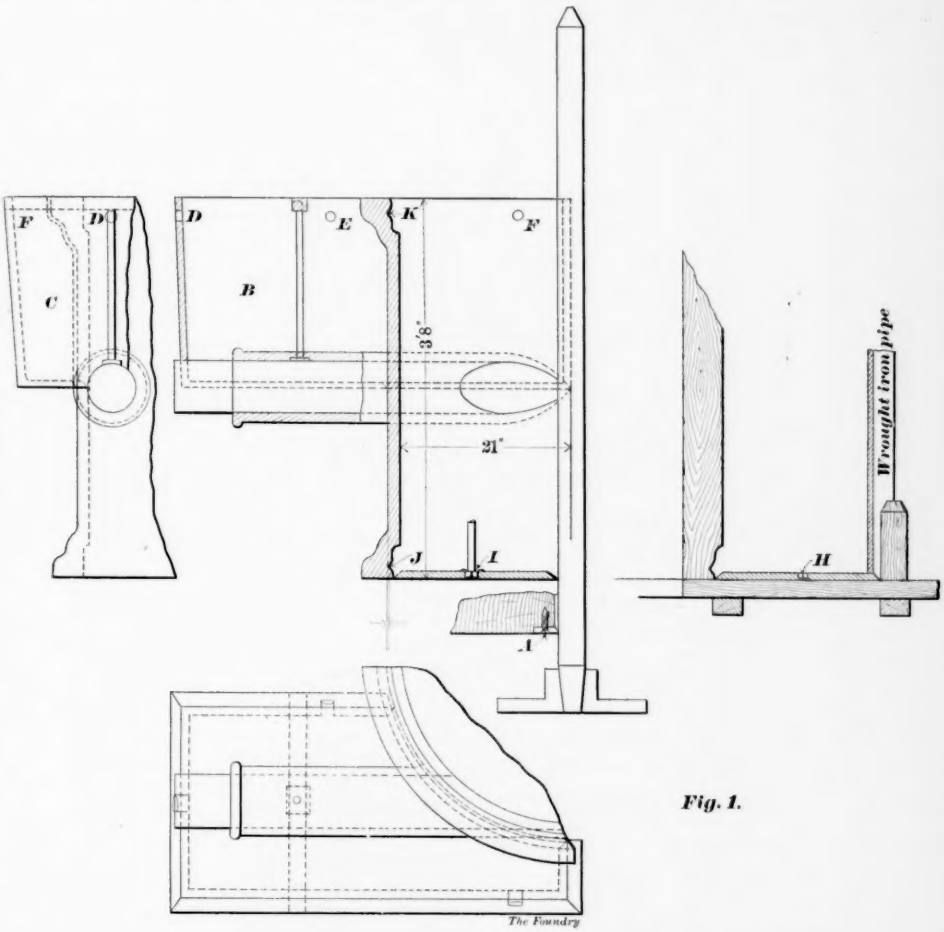


Fig. 1.

We allowed the spindle plenty of clearance to pass through by placing an old piece of pipe over the plug in the bottom of

the core box, thus keeping the cinders from filling this space. We had no print on either top or bottom of main core, but as the spindle stood about two inches above the floor all the molder had to do was to let the spindle enter the bottom plate, and the core being central would adjust itself automatically. In setting the nozzle core we had to use three chaplets, one at the bottom, one at the top and one to keep this core against the main core. The bar cast across top of drawback box served as a support for the top chaplet. There was one bad casting in this lot, which was caused by the runner bursting.

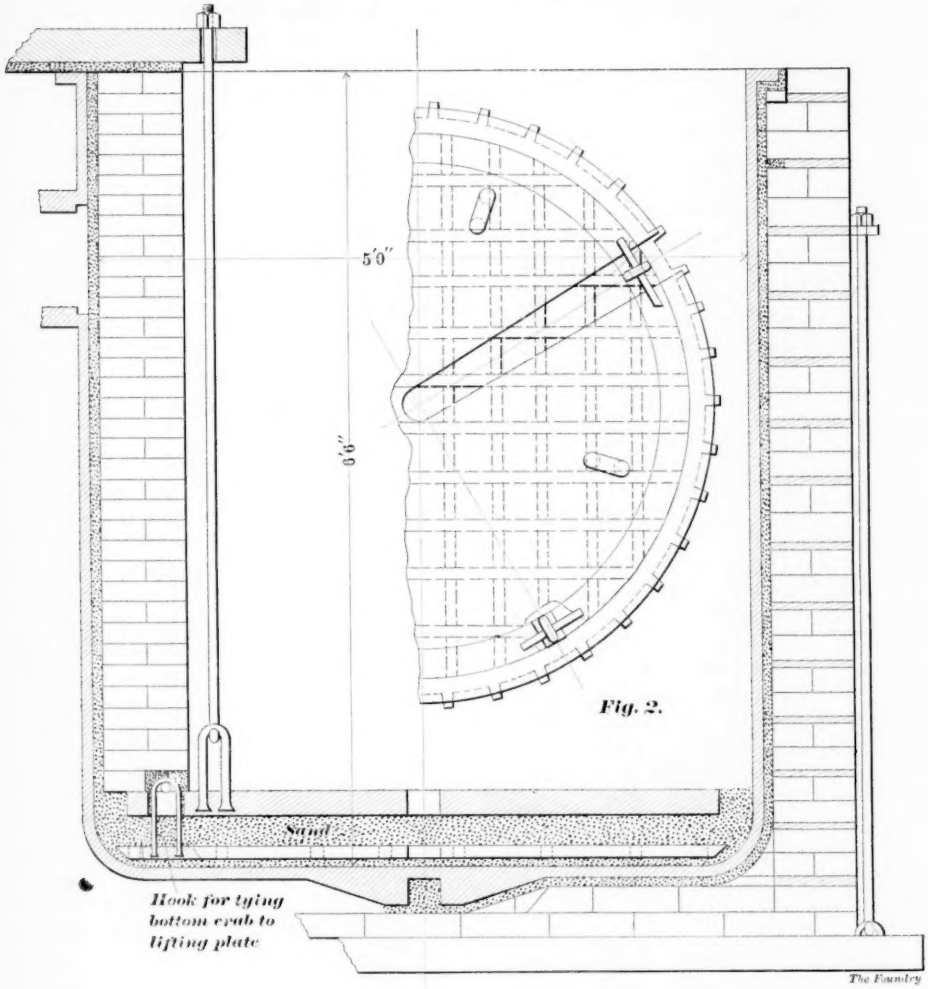


Fig. 2.

Another job with which the writer has just gotten through is eight chemical retorts five feet in diameter, six feet six inches deep, with the bottom cast solid. I do not want to be understood as calling either of these jobs large or difficult castings to make. Our work is marine and general jobbing, and therefore these castings are of rather a plain kind to us. My object in writing this article is to describe what I consider cheap rigs. I might have made a cast iron casing, but such would have cost a great deal, and we would have had to make a rig for the casing, and it has been my experience, now that the job is done, that the rig we did get up answered the purpose just as well.

In molding the retorts shown in Fig. 2 we started by casting a solid bottom plate four inches thick, with eight lugs, also six

staples cast in one inch from edges of plate. It will readily be understood that there was not only a hard strain, but a lift on the core amounting to upwards of thirty tons. After building up to where the bottom of our core came we put on a stiffening ring, leaving one and one-half inches clearance outside of the retort. The ring being seven and one-half inches wide, gave us a nine-inch wall with sufficient clearance for our outside bolts to tie the rings together. We built up in this way only until we reached the top of our nozzle, putting a ring every two courses of brick, the nozzle being about five feet from the bottom of casting. On the top ring we had cast some small lugs with holes therein to match the staples in our bottom plate, through which we fastened hook bolts from the staples of the bottom ring and fastened these down securely. This part of the mold we saved every time, as the shrinkage of the casting allowed us to hoist same out without disturbing the bricks.

Some molders might say why not continue this process clear to the top of the mold. If I had done so, the nozzle would not have allowed me to take out the casting. Above the portion of the mold already bolted together we still put on rings, the object of using so many of these being to save ramming up and digging out, which would have cost more than the making of the whole job. The rings cost us very little, except the iron, and of course we had this left after the job was finished. We cast five rings in the same mold, casting one at the beginning of the heat and letting it cool a little, and then casting another, and so on.

We made the first mold above the floor, as we could handle our rig more conveniently there, and also dry the mold better than in the oven. Before putting the mold in the pit we placed the spindle center below same, and after the mold was dry we lowered same in place, being very careful to locate it so as to have the spindle center in a central position. We next put strong stirrups on the lugs of bottom plate long enough to come up to the floor line. We then filled up the pit with dry sand and rubbish, in the meantime making our core.

From the shape of the core it will be seen that we needed something to form the bottom portion of same. We built a form of bricks and mud up to where the fillet ended, and dried this, afterwards putting on a coat of linseed oil, which, when dry, made the whole thing as hard as a board. We next made a core arbor as shown, and rammed sand in and about it for five inches high, when we put our lifting plate on top of this, afterwards building up the full length with a nine-inch wall without using any stiffening rings.

We first thought of putting a tapered plate in the wall of the core, to be taken out after casting, but were afraid of doing so, as it would have a tendency to weaken the wall. After casting we found that it took only a few minutes to cut a row of bricks out of the core to give the casting a chance to shrink, and as our lifter plate and core arbor were each provided with a slot this job was easy of accomplishment.

In putting our mold together we put thickness pieces on the bottom of same and lowered our core down on these, then we put our top plate on, which had eight lugs to match an equal number on the bottom plate, and also lugs inside to match lifting plate in core. After we had bolted our core to the top plate and got the outside marked we lifted our core out and then removed the thickness pieces, afterwards placing the nozzle core in position, and the mold was ready to close.

To secure the nozzle we had a print long enough to allow us to have the core set back far enough so that there was no danger of the main core striking it in going down. After we had closed our mold we then, by means of two rods placed in the nozzle core, moved it inwards against the main core. In pouring we dropped the metal from the top, and all the eight castings were made without a mishap. As we saved ramming up and digging out our pit each time, and also saved the greater part of our mold, it brought the cost of making these castings down to the minimum.

Foreman or Chemist.

Much has been written as to dividing the responsibility in foundry management between chemist and foreman molder. The subject is of such vital importance to founders that much more will have to be written and said before the subject is thoroughly thrashed out. Many arguments yet remain on either side.

Successful foundry management is one of

the most complex of problems and it is one that comparatively few men are qualified to tackle. It requires wide experience, aptitude and special training. It takes a man possessing all these qualities nearly all his time to keep his foundry on the right side of the firm's books. Inefficient management soon tells and the profit account rapidly begins to look blue. To ward off this loss of profit several firms have adopted the plan of holding the foreman responsible for the molding only, while a chemist is put in charge of the metal mixing and melting. It is quite likely that this plan may answer in certain cases but that it is to be a universal success remains open to doubt. Foundries are skittish things to handle. They are extremely sensitive and the least alteration in the handling makes an apparent difference. The adage that two heads are better than one will not permit of application when it comes to a question of foundry management. The very nature of foundry work is convincing as to the futility of attempting to run with two heads. Wastes may be caused through faults in molding or through errors in melting and mixing. One can quite enjoy the thought of an angry superintendent trying to tack the blame of bad castings, first on to the foreman and then to the chemist, these latter gentlemen each in turn denying responsibility. Such a state of management would give rise to numberless scenes of this kind.

The chemist can analyze his iron and calculate out his mixtures accordingly. He can estimate the impurities of his coke, limestone, etc., calculate the amount of air required for the combustion of that coke and work the furnace beautifully—on paper. When he gets on to the charging stage conditions change considerably and a little practice is found necessary to go with the theory. Then again the requirements of castings vary and in judging these requirements practical experience must come largely into play. Handling the help around the furnace and preparing the latter for melting requires something further than is gained by a three or four years' course in a college or works laboratory.

Admitting that working with divided responsibility is not likely to prove a success can we say that the old style of running with a foreman trained only as a molder and who has picked up a few scraps of information as to mixing and melting is likely to prove effective in foundries of to-day which have an ever increasing competition to meet? No we cannot say that this plan is likely to be successful either.

Foundry foremen of this age to be really successful must be specially trained for the work. This training must comprise a thorough knowledge of practical work, that is the making of molds by the best methods in either green, dry sand or loam. This also includes the devising of special tackle for the quick production of such molds. It must include a knowledge of metallurgy as far as it affects the metals they handle, and a knowledge of the laws governing crystallization and contraction of metals. In addition to this training an up-to-date foundry foreman should be able to intelligently read a mechanical drawing, to get at his working expenses accurately and above all to handle men efficiently.

Surely a long indictment and many an old sore head will question the advisability of mastering all these things. But wise men do not look on these questions as mere fads, they find the game worth the candle and a wax candle is better than a tallow candle any day.

But this training will not be gained without considerable trouble and personal discomfort. If a young fellow means to be a foreman some day, the first point to which he must pay special attention is, of course, the molding, which must be as perfect as he can make it, and he must gain experience under as many different conditions as possible. Whilst doing this the great proportion of his evenings must be spent in study—real study—no half measures, starting with a couple of years in mathematics and machine drawing. These subjects can be taken up at almost any evening science school during the winter months. A session devoted to elementary chemistry could follow this with advantage and the following three years should be devoted to the study of metallurgy. This subject may be divided into two sections:

1. Iron and steel metallurgy.
2. The metallurgy of copper and its alloys.

The section most likely to meet individual requirements should be taken and three

years of hard and close study will not be any too long a time to devote to it. This metallurgy must be thorough. It should comprise analysis, chemical, mechanical and microscopical and mixing and melting from the results of such analysis. The course should also touch upon furnace design and construction, fuels and refractory materials.

A training such as is here indicated will fit a molder to act as foreman, with good hope of his attaining a reasonable amount of success.

To the writer's mind this is the best solution of the foundry management question. The foundry giving best results will be the one operated by an essentially practical foreman, who has had scientific training and who knows how to use his theory in combination with practice. The difficulties of foundry work do not permit of a divided responsibility and such establishments as are operated in this way illustrate well the old saw, of a "house divided against itself,

P. LONGMUIR.

The Hammer Core Machine.

One of the exhibits, at the recent convention of the American Foundrymen's Association was the Hammer Core Machine, shown in actual operation by the inventor, Mr. Hammer.

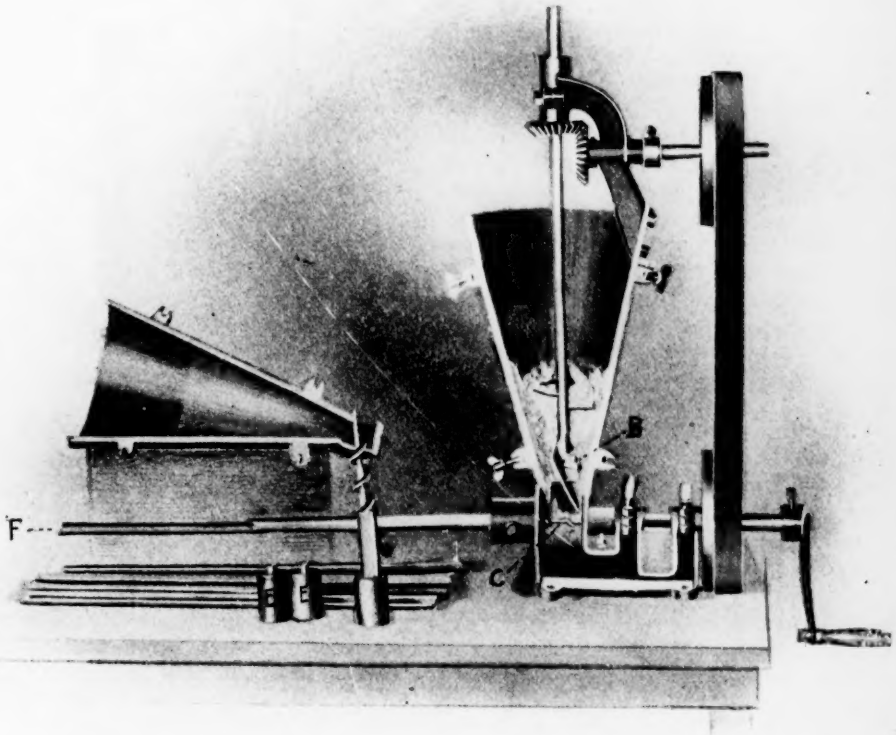


FIG. 1. THE HAMMER CORE MACHINE.

This machine is intended to be used for what is commonly known as stock cores, that is, cores having a uniform measurement throughout. One difficulty which has always been experienced in this class of cores, when made by hand in the ordinary way, is to obtain a core with a venthole located centrally throughout the body of the core, especially in the small sizes.

With the Hammer Core Machine it is impossible to have the venthole in any other

position, as same is made around what may be termed a mandril when the core is being made. In the sectional illustration of the machine, Fig. 1, A, is the funnel through which the sand is fed into the machine. By turning the crank the sand is forced downwards by the screw, B, onto the screw, C, which is the exact size of the diameter of the core, and has a projecting point, D, Fig. 2, which forms the vent in the core.

The capacity of the machine is so great that but a few minutes are required to make cores enough to last the average shop a week. The Brown Bros. Mfg. Co., of Chicago, are the manufacturers.

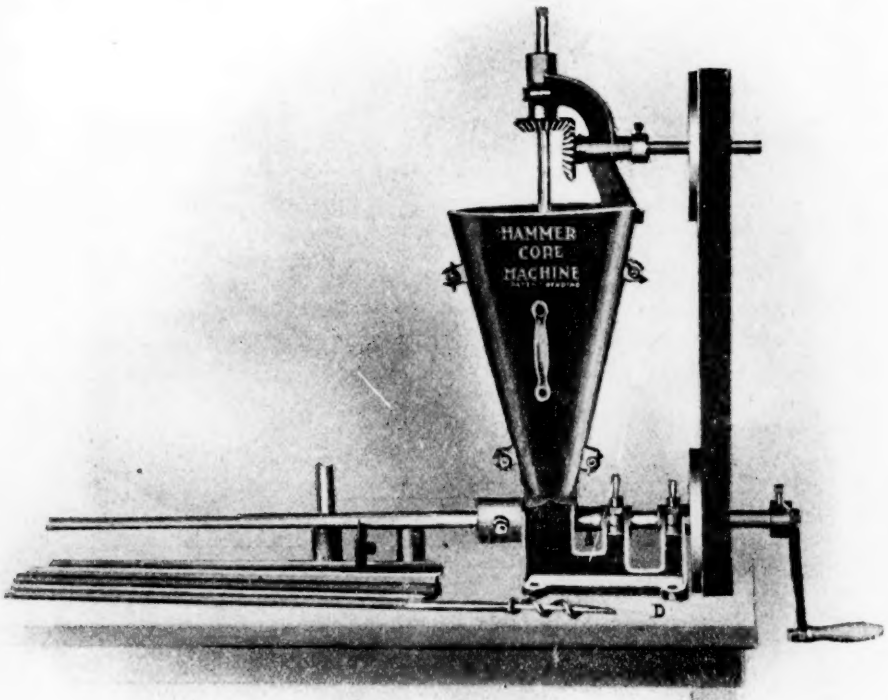


FIG. 2 THE HAMMER CORE MACHINE.

As the core is being formed by the sand being forced through the cylinder, E, onto the drier, F, and the vent formed at the same time, it is apparent that there can be produced nothing but perfect cores. A change of cylinder to one having a different diameter and the substitution of a drier having the same measure, is all that is necessary to make a core of another size.

Fig. 1 shows the machine as it can be taken apart for cleaning. Fig. 2 is an illustration of its appearance in operation.

Engine Building Moving West.

One who learns of the large number of steam engines purchased in eastern cities by the manufacturers of New England naturally wonders why engines built in New England are not given the preference. There was a time when the Corliss engines, designed in this city, were used almost exclusively in the mills of Rhode Island, Connecticut, Massachusetts, New Hampshire and Maine. Providence engines were sold also in the markets of the west and south, and were recognized as the best in the country.

To the regret of all who take pride in the supremacy of local products, the conditions have changed during the past few years.

Users of engines of large powers no longer regard Providence as the center of the engine industry. The western makers have invaded the New England territory and are competing successfully with local builders. Probably western designers and mechanics cannot produce better engines than can be made here, but it is very evident that the engines shipped to the east from the shores of Lake Michigan are of high grade, because the buyers thoroughly appreciate the importance of quality in a locality where expensive fuel calls for economy in the use of steam.

The preference manifested for western engines cannot, therefore, be attributed to a desire to obtain power plans at low cost without regard to grade of material or workmanship. It may be taken for granted that engines from Wisconsin do not suffer by comparison with those produced in any other section of the United States or in Europe, and this assumption is supported by the fact that foreign corporations, familiar with the output of English and Continental shops, are placing orders in Milwaukee.

This state of affairs is not creditable to the city in which the Corliss engine was developed, and which until a few years ago had a monoply of the engine trade of New England. There is no valid reason why the northern Atlantic states should be compelled to look to the west for power to drive spindles and street railway generators. But purchasers cannot be censured for saving money when there is no sacrifice in quality. Undoubtedly the popularity of western engines can be attributed to price; if two machines of equal merit are offered and there is a difference of $5,000 or $10,000 in cost, the wisdom of decision in favor of the western engine cannot be questioned.

The obvious thing to be done is to compete with outside makers both in price and quality and to offer the best New England designers and machinists sufficient inducements to stay at home instead of helping to build up the industries of the west. It is important, also, to study the methods which have made the west the center of Corliss engine production. Will not investigation show that eastern builders are using tools which were antiquated several years ago, and do not reduce the cost of labor to the minimum?

According to well authenticated reports the new shops of the west are equipped with machine tools of the latest pattern, which probably are 40 or 50 per cent more economical in operation than the tools of older design. The development of special machines during the past few years has helped largely in reducing shop expenses, and if, as assumed, the western builders are employing only tools of this description, it is not difficult to account for the placing of their engines in the eastern states.—Providence (R. I.) Journal.

Machine Foundations.

The foundations required by machine tools of various kinds are almost as diversified in their character as the tools themselves. The support for the self-contained machine presents a problem easy of solution, and which may be considered of minor importance. But the tool which demands, in order that it may produce the best work of which it is capable, a rigid and unyielding foundation is the one which bothers the engineer in setting. The difficulty is increased when several supports are required, and when the size of the machine makes it essential to build piers in no way connected one with another. The chances for error, the liability of subsequent settling, and the trouble in obtaining true alignment are matters which require the most careful treatment both in the design and execution of the work.

A method which would appear to embody many features of excellence has been proposed by the Newton Machine Tool Works, who, in their new shop, expect to employ foundations of a novel character, and which it is expected will eliminate many of the difficulties heretofore encountered. They intend to employ cast iron beams formed with T-slots similar to the slots in the plate of an erecting floor, and designed for the reception of the hold-down bolts. These beams will, of course, be of such length as may be called for by the machine to be placed upon them. They will be placed on a level with the shop floor, and will be held in a mass of concrete resting upon a suitable foundation. The erection of such a base should be a comparatively simple matter, since after the beams have been leveled and aligned they are simply held in position until the concrete in which they are embedded has thoroughly hardened.

A particular advantage possessed by this plan is that while the machine and its foundation are rigidly united, provision is made

for the easy disengagement of the tool, if such a course should at any time be advisable. The moving of a machine held down by bolts embedded in concrete is a task of no indifferent proportions, while the bolts themselves form an obstruction to the setting of any other machine on that foundation, and may therefore become objectionable. The new method offers in contrast a wide elasticity, since the bolts can be shifted in order to fit a machine of different design. The plan presents admirable facilities for changing the location of the machine, and for even abandoning a foundation without in any way interfering with the shop floor and at a merely nominal expense.—Iron Age.

Protection of Blast Furnace Linings.*

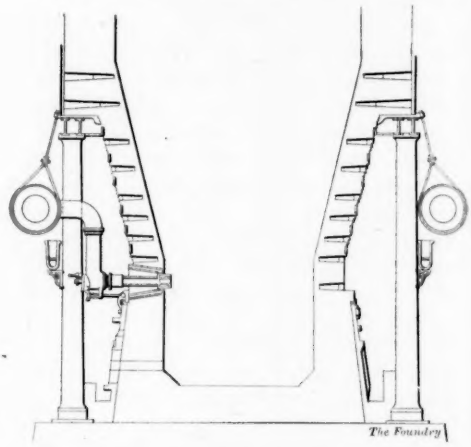
Furnace men of the present day agree very nearly as to the best cooling devices for the protection of blast furnace hearths and boshes, and the best location of the cooling system in the brick work for the maintenance of the favorable furnace lines throughout the blast. The replaceable bronze and copper plates are practically faultless; and there seems to be no reason why a furnace hearth and bosh should not be held in good condition, by intelligent management and the use of replaceable plates, for a period several times the length of the average blasts of to-day.

While furnace men have taken these precautions to protect the hearth and bosh beyond the life of the lining, the portion of the lining above the mantle has been partly protected by some and wholly neglected by others. Some would not construct a furnace without mantle plates, and others would not construct a furnace with them. In most cases, furnace men have either trusted to Providence or to the bosh plates for the continuance of favorable working conditions above the mantle, and the prolongation of the life of the lining; consequently furnaces are constantly blown out for repairs to the lining or for relining, when the hearth and bosh are in good enough condition to last through another blast.

The following extract from one of Mr. James Gayley's contributions on American blast furnace practice is of interest in this connection:

"One point particularly worthy of mention has been observed recently, viz.: That the removable bosh plates of bronze and copper protect not only the bosh wall, but also the whole of the upper lining, from the point where the stock strikes against the top lining down to the mantle. The wear of the lining for double the production is only about half what it was when the bosh was protected differently. The result, as amply demonstrated by practice, is that the fuel consumption does not increase with the length of the blast, as has been the usual experience; and it also follows that the production maintains its regularity."

In other words, according to Mr. Gayley's statement, the melting and wearing away of the lining to large diameter above the mantle is retarded so as to increase the economical working life of the furnace 100 per cent.



Section of Blast-Furnace, with Replaceable Copper Plates Up to the Mantle, and Double-Pipe Iron Plates Above.

The working life of a furnace depends upon the ability of the lining, from the stock line to the mantle, to withstand melting or wearing away, which causes extravagant fuel consumption and irregular working. Consequently, it seems that furnace men should endeavor to ascertain the lines necessary to insure good economical working conditions, and to protect these lines as the hearth and bosh are protected, thereby making the life of the lining from the mantle to the top equal to the life of the hearth and bosh.

Mr. F. E. Bachman, my predecessor in charge of the Buffalo furnace, informs me that the furnace, as put in blast in 1895, had the following dimensions: Diameter of

*Paper contributed by S. S. Hartranft to the Canadian meeting of the American Institute of Engineers.

hearth, 11 ft.; diameter of bosh, 18 ft.; angle of bosh, 75 deg.; and that it was provided with replaceable copper plates up to the mantle, three rows of double pipe cast iron plates of the ordinary type above the mantle. The inner 1¼ in. pipe was 2½ in. from the inner edge of the plate and the outer 1¼ in. pipe was 6 in. from the inner pipe, and parallel to it, both running lengthwise through the plate, which was 8 ft. in length. The first row of these plates was placed 5 in. above the mantle, with the front edge of each plate 4½ in. from the inside line of the brick work; the second row was 2½ ft. above the first, with the front edge of each plate 9 in. from the inside line of the brick work; and the third row was 2½ ft. above the second, with the front edge of each plate 4½ in. from the inside line of the brick work.

After blowing in, the furnace worked very well for the greater part of the first year, when it began hanging and slipping, which gradually became so pronounced as to interfere materially with the grade of the iron. About the end of the first year, the water circulation was lost on the inner pipes of the three rows of plates above described; after which there was no more hanging and slipping, while the grade of the iron improved and the output increased. In about a year and a half from the time the inner rows of pipes were lost, the outer rows were lost also; and, there being no water protection left, the furnace soon enlarged at this point to such an unfavorable diameter and shape that it became necessary to blow out at the end of the third year.

On several occasions, I have cut the water off from the inside pipes in three or four of the upper rows of bosh plates, usually after the furnace had been in blast a year or more, and the inner pipes had been lost in a few of these plates. A quick and favorable response was invariably noticed, in the way of improvement in grade and increase in output.

The ledge or offset that forms above the upper rows of plates by the wearing away of the brick work from the original lines interferes with the regular descent of the stock in proportion as it grows larger; the effects of which (when the plates are placed, as is customary, with the front edge of each a few inches from the inside line of the brick work) are generally noticeable about the middle of the blast. I think that the wearing away of the lining could be sufficiently retarded to insure the retention of favorable lines, through the period of an average blast, by six rows of plates above the mantle, placed 2½ ft. apart, with their front edges at least 9 in. from the inside line of the brick work.

It hs been the experience of some furnace men, who place plates above the mantle and extend them through the lining until the front edge of each plate is within a few inches of the inside of the brick work, that the furnace does better work when the first row of pipes in the plates burn off, and the diameter of the furnace enlarges until the second or rear row of pipes prevents further enlargement in diameter. When the last row of pipes in these plates burn off, and all protection is lost, a further enlargement in diameter causes extravagant fuel consumption and irregular working, to such an extent that it becomes necessary to blow out the furnace and put in a new lining. It seems, therefore, from experience with these plates, that in a furnace of modern lines, to secure the protection of plates and the retention of favorable lines for a period more nearly approaching the life of the hearth and bosh, the plates should be placed with the front edge from 9 to 12 in. from the inside of the brick work. This will permit an enlargement of diameter of from 18 to 24 in., without destruction of the plates; and if the furnace can be held by the plates after this increase in diameter, a blast of regular work somewhat longer than orinary might be expected. Plates set back from 9 to 12 in. from the inside of the brick work would not suffer so much from heat and abrasion, and would, no doubt, hold out for a much longer period than when placed according to the present custom. The construction might be such as to permit replaceable plates similar to the present replaceable bosh plates; and when the most favorable lines to which the furnace should be held above the mantle had been determined, these plates could be placed with their front edges as close to the inside line of the brick work as many furnace men place their bosh plates at the present time.

Our illustration is from a drawing by an eminent furnace engineer, and shows the hearth and bosh of an 18x80 ft. furnace with an 11 ft. hearth and 75 deg. angle of bosh,

fitted with replaceable copper plates up to the mantle, and double pipe iron plates above the mantle.

I have had an opportunity recently to observe the result of fitting up a furnace with rows of solid cast iron plates at the stock line; and I am much pleased to find how well these plates, with an inner edge 5 in. wide, placed in rows one foot apart, have worn, and have protected the lining at this point. I would not be surprised to see, before long, furnace stacks plated from the mantle to a point above the stock line with water plates and solid plates. The only question difficult to decide will probably be the point in the ascent at which the water plates should stop and the solid plates begin.

Considering the great progress of furnace practice in recent years, especially in the matter of the protection given to furnace hearths and boshes, it seems that the linings from the mantle up have not had a corresponding share of protection, and that in the near future this portion of the stack will be equally protected with the hearth and bosh from the effects of heat and abrasion, so that a great increase in the length of blasts, or the amount of iron made on one lining, may be expected.

Twenty-Three New Furnaces.

The Bulletin of the American Iron & Steel Association contains notices of the erection of four new furnaces—two at South Chicago, by the Illinois Steel Company; one at Thomas, Ala., by the Pioneer Mining & Manufacturing Company; and one at La Follette, Tenn., by the La Follette Coal, Iron & Railway Company. In addition to the above the Carnegie Steel Company are building two large furnaces at Rankin Station; the Buffalo Charcoal Iron Company have about completed a charcoal furnace at Buffalo, N. Y.; Joseph Warren is building a new furnace at Port Oram, N. J.; the Warwick Iron & Steel Company are building a new furnace at Pottstown, Pa.; the American Steel & Wire Company are building a new furnace at Neville Island, near Pittsburgh, Pa., and are erecting an additional stack at their Central furnaces at Cleveland, O.; Jones & Laughlin, Limited, are adding a new furnace to their Eliza plant, at Pittsburgh; the National Steel Company are erecting three new furnaces, one at New Castle, Pa., one at Mingo Junction, O., and one at Youngstown, O., and are also building another stack at Mingo Junction to replace one of their old furnaces now in use; the Sharon Steel Company are erecting a new furnace at Sharon, Pa.; the Roane Iron Company are erecting a new furnace at Rockwood, Tenn.; the Columbus Iron & Steel Company have about completed the erection of two furnaces at Columbus, O.; the Globe Iron Company are erecting a new furnace at Jackson, O.; the Iroquois Iron Company are erecting a new furnace at Chicago, Ill., and the Colorado Fuel & Iron Company are erecting a new furnace at Pueblo, Col.

Trusts, Labor Unions and Arbitration.

The Industrial Commission in taking testimony at Washington had before them as the first witness Labor Commissioner John McMackin of New York, who gave some interesting evidence regarding the relations between trusts and labor unions. In speaking of the development of the trusts Mr. McMackin said that, up to the present time, the growth of the labor unions had about kept pace with the growth of the trusts, so that when a controversy arose between them the unions had been able to hold their own and obtain fair terms. Thus they had not suffered from the growth of trusts and had, as a rule, maintained friendly relations with those combinations.

The chief danger, in the opinion of the Labor Commissioner, in the present industrial situation is that the success of the trusts in conducting busines enterprises will lead to the popular belief that the concentration of all business enterprises under one general management is a good thing and that thus state socialism may creep in.

Regarding compulsory arbitration of industrial disputes, the witness said that it did not appeal to him as a good thing, unless the labor unions, which were parties to the arbitration, became incorporated, so that they could be held to the performance of any contract into which they entered on behalf of their members.

The present tendency of labor unions, Mr. McMackin said, was to incorporate. The statement, however, was questioned by members of the commission. Arbitration in New York, he continued, had not been found to be very satisfactory. Out of 455 strikes in the state last year the State Board of Arbitra-

tion had settled but 46. Labor unions were suspicious of legal boards of arbitration, he said. Nevertheless, he believed that compulsory arbitration was desirable where such semi-public utilities as telegraph and telephone companies and transportation lines were involved, and where the general public suffered acutely by an interruption of business.

Mixing Iron by Analysis.

BY W. G. SCOTT.

In the manufacture of steel by the modern process, a chemical analysis of the ore, pig iron, fuel, etc., is considered an absolute necessity in order to meet the specifications of the architect, builder, contractor, or the manufacturer.

When we take into consideration the fact that a steel of an exact specified strength, a given per cent of elongation, and a desired degree of hardness is obtainable, it is simply marvelous.

What chemistry has done for the steel manufacturer and blast furnace it can do for the founder.

Theory in the application of chemistry to the foundry business is all right to a certain extent, but conditions being different, it follows that not only the chemical composition, but the physical properties of the iron must be carefully considered.

Chemistry devoid of "too much theory" and combined with good common sense is the keystone of success in foundry practice.

There is, or should be, no secrets in the application of chemistry to foundry practice.

The effect of the metalloids, silicon, sulphur, etc., on iron, is a fixed law of nature, and when exceptions occur it will be found on investigation that some outside influence caused the change.

Nearly all of the large manufacturing concerns, like the E. P. Allis Co., Gates Iron Works, Fraser & Chalmer's, Crane Manufacturing Co., McCormick Harvesting Machine Co., Deering Harvester Co., Plano Manufacturing Co., Milwaukee Harvester Co., J. I. Case Threshing Machine Co., Warder, Bushnell & Glessner Co., Western Electric Co., Pope Manufacturing Co., Pennsylvania Railroad Co., and hundreds of others maintain a chemical and physical laboratory.

These large plants test all material purchased, and as a rule, buy pig iron, steel, etc., on specification, by which means they are reasonably assured of the quality of their product.

Large concerns operating a foundry in connection with their business are now mixing iron by analysis, and those who have made a success of this feature are inclined to keep the method secret, believing that "if you have a good thing you should keep it."

It is only recently that the immense agricultural implement manufacturers have taken up the mixing of iron in the foundry by analysis.

To Mr. G. H. Schulte, vice-president and general manager of the Milwaukee Harvester Co., belongs the honor of having first introduced the method in this kind of a plant.

At the present time nearly all of these large institutions are now doing the same.

Mr. Schulte put in a laboratory and commenced mixing iron by analysis in the face of much opposition and prejudice, overcoming many obstacles, and demonstrating conclusively that this method was the proper one. In one instance, when the foreman predicted a failure, Mr. Schulte remarked that he would risk the loss of the entire output in order to prove his faith in mixing iron by this method.

In order to mix by analysis and get practical results, it is quite necessary that the founder should know the composition of not only the pig iron, but the fuel, limestone, sand, etc.

Buying iron by fracture is a thing of the past, and small foundries which are unable to maintain a laboratory, now ask for an analysis from the furnace, by which means the foundryman can get a pretty good idea as to the value of the pig in regard to its strength, softness, shrinkage, and scrap-carrying properties.

In order to make a success of mixing iron by analysis, it is quite essential that the chemist and foundryman work in harmony and both strive to improve the quality of the castings as well as to reduce the cost.

With the two factions at war with each other, the final result is generally a failure, as the foundryman can queer the chemist in many ways, especially if he has absolute control of the mixing.

In the event of the chemist being a practical founder he may be able to overcome most of the trouble; the better plan, however, is to have the chemist attend strictly to the analytical work, and let the mixing card be made out by a disinterested party or the foundry clerk, thus leaving the foundry foreman free to attend to the management of the men and to the physical manipulation of the iron.

The object of this paper is to describe the methods used in several large foundries making gray iron, malleable and steel castings, also brass and bronze work. These several concerns are entirely separate, but have the chemical work done in one laboratory.

There is much friendly rivalry between the different institutions, each foundry trying to make the best record in regard to strength, finish and reduced cost.

Each concern gets a copy of the chemical analysis and physical test of every individual heat taken off, consequently each foreman knows the next day just what grade of iron was turned out, and as all bad castings, defects, etc., are recorded, it furnishes valuable data in regard to the influence of certain metalloids.

Our first paper will relate to the methods used by the J. I. Case Threshing Machine Co. of Racine, Wis.

This plant turns out castings varying in weight from one ounce to several thousand pounds, and ranging in quality from a close grained, compression cylinder, to common grate bars.

The foundry is operated under contract by Mr. E. H. Walker, who is a very intelligent and up-to-date foundryman.

The iron is mixed strictly by analysis, and the output is subject to specification.

No castings are accepted which fail to meet the requirements of the specification, which is very rigid, and would be almost impossible to fill were the iron to be mixed by guess work.

A certain class of the work requires an exact shrinkage, i. e., concaves, etc.; consequently this feature is distinctly specified.

The J. I. Case laboratory is one of the best equipped institutions of its kind in the country, and the physical part is replete with every kind of modern testing machine.

Mr. Frederick Robinson, vice-president and general manager of the Case works, is the founder of this laboratory, and has spared no expense in fitting it out with all the necessary apparatus.

Mr. Robinson is a practical business man, and is able to judge from an analysis the quality of material fully as well as any of the chemists.

Nearly everything purchased for this large concern is bought on specification, and several years of experience has shown that this method is most satisfactory to both seller and buyer.

A specification answers two purposes, one of which is in buying the material, the other in fixing a limit or a dividing line between good and bad material.

Before going into the detail methods of mixing iron, we shall submit several of the J. I. Case Threshing Machine Co.'s specifications which are closely related to our subject, and include pig iron, scrap iron, foundry coke, molding sand, and foundry castings, i. e., gray-iron.

No. 269—Specifications for Foundry Pig Iron.

Under these specifications we desire a good, clean iron, as free as possible from dross, kish, oxide, sand, etc.

The per cent of "sows" must not vary to any great extent from the usual amount found in a strictly graded iron, according to the old fracture method.

All grades of pig iron will be bought strictly by analysis, and must conform to the following specified per cents.

Foundry No. 1.

Silicon,	must not be less than	2.50 per cent
Sulphur,	must not exceed.....	.03 per cent
Phosphorus,	should not exceeed...	.60 per cent
Manganese,	should not exceed....	.50 per cent
Total Carbon, not specified		

The carbons will usually be between 3.00 and 4.50 per cent in this grade.

Any car of No. 1 foundry pig which shows on analysis less than 2.40 per cent of silicon or more than 0.035 per cent of sulphur will be rejected. (See remarks under head of note.)

Foundry No. 2.

Silicon,	must not be less than	1.95 per cent
Sulphur,	must not exceed.....	.04 per cent
Phosphorus,	should not exceed....	.70 per cent
Manganese,	should not exceed....	.70 per cent
Total Carbon, not specified.		

The carbons in No. 2 will generally range from 2.90 to 4.20 per cent.

Any car of No. 2 foundry pig which shows

on analysis less than 1.85 per cent of silicon or more than 0.045 per cent of sulphur will be rejected. (See note.)

Foundry No. 3.

Silicon,	must not be less than	1.35 per cent
Sulphur,	must not exceed.....	.05 per cent
Phosphorus,	should not exceed...	.80 per cent
Manganese,	should not exceed....	.90 per cent

Total Carbon, not specified.

The carbons in this grade will usually be between 2.50 and 4.00 per cent.

Any car of No. 3 foundry which shows on analysis less than 1.25 per cent of silicon or more than 0.055 per cent of sulphur will be rejected.

Note.—It is distinctly understood that all grades of pig iron will be bought according to analysis and not by fracture.

As we mix by analysis in the foundry, it necessarily follows that the pig iron should be according to specifications; furthermore if we accept an iron as No. 2 which fails to fill the No. 1 conditions, we might eventually be overstocked with No. 2 and be unable to get the results aimed at in the cupola mixture; consequently an iron sold as No. 1 or any other specified grade, will be rejected if not strictly within the specifications for said grade.

When a car of pig iron is received it will immediately be sampled by an experienced man (professional sampler), who will select a certain number of pigs from different parts of the car, which according to his judgment shall represent the average quality of the iron. These pigs will be broken and drillings taken from the face of the fracture will be sent to the laboratory for a chemical analysis. The analysis will decide the acceptance or rejectment of the iron.

Rejected cars will be held subject to the shipper's order.

In case of dispute, the furnace or the seller shall have the right to resample the iron in conjunction with the buyer, each to select five pigs.

Drillings from the ten pigs, after being well mixed, will be divided into three different samples, one lot to be analyzed by the furnace, one by our laboratory, and one by a disinterested chemist, agreed upon by the parties in dispute.

The two analyses nearest alike will be accepted as the proper chemical composition of the iron.

In all chemical work relating to pig or cast iron, it is understood that the standardized drillings furnished by the American Foundrymen's Association are to be used as "standards."

The following chemical methods are used in our laboratory, viz.

Silicon—Drown's method.

Sulphur—Evolution and titration with iodine (volumetric), as a rapid method, and the oxidation method (gravimetric) in all cases of dispute.

Phosphorus—"Emmerton's Method" for rapid work, and the "Molydate Magnesia" method for very accurate determinations.

Manganese—Deshay's or the colormetric method for rapid work, and the "Acetate Process" for extremely accurate work.

Carbons—Carbons are worked by the colormetric and combustion methods.

In case of dispute, check analyses are made by gravimetric methods.

No. 270—Silver Gray (S. G.) or Silicon Pig.

Under this specification we expect a pig iron medium high in silicon and not too low in graphitic carbon. This iron is to be used as a softener.

Silicon,	must not be less than	3.00 per cent
	and should not be more than	5.50 per cent
Sulphur,	must not exceed.....	.04 per cent
Phosphorus,	should not exceed....	.90 per cent
Manganese,	should not be less than	.30 per cent
Total Carbon,	should not be less than	2.50 per cent

Any car of S. G. iron, showing on analysis less than 3.00 per cent of silicon, or more than 0.055 per cent of sulphur, will be rejected.

No. 271—Ferro-Silicon Pig Iron.

Under this specification we prefer a pig iron with about 8.00 per cent silicon.

The general range for silicon in this grade is from 6.00 to 12.00 per cent.

Silicon,	must not be less than	7.00 per cent
	or more than.....	12.50 per cent
Sulphur,	must not exceed.....	.04 per cent
Manganese,	not specified.	

Total Carbon, not specified.

As a rule the graphitic carbon will be low, varying from 3.00 to 0.50 per cent.

Manganese may occasionally vary from 0.20 to 3.00 per cent. or more.

Cars will be rejected which show less than 6.00 per cent. of silicon, or more than 0.045 per cent. of sulphur.

No. 272—Manganese Pig Manganiferous Iron.

In this specification we desire an iron of from 1.00 to 2.50 per cent. manganese.

The ordinary No. 1 Pig Iron, running about 1.50 per cent. in manganese, will fill all the conditions required.

Silicon,	should not be less than	2.50 per cent
Sulphur,	must not exceed.....	.04 per cent
Phosphorus,	should not exceed....	.70 per cent
Manganese,	must not be less than	.90 per cent
Carbon,	not specified.	

As a rule, the higher the manganese, the greater the proportion of combined carbon.

Combined carbon may range from 0.30 to 3.00 per cent., while the graphitic carbon may vary from 0.40 to 3.50 per cent.

Note.—A few remarks on Manganiferous Irons may help to define the dividing line between the ordinary Foundry Pig and the regular manganese iron.

Manganese Pig is an ordinary iron made from ore containing somewhat more manganese than the regular foundry irons; it will run from 0.80 to 3.50 per cent. in manganese. It is added to foundry pig, in cupola practice, to raise the combined carbon, thereby increasing the strength. In a measure it neutralizes the effect of sulphur, removes excess of gas and prevents blow holes. It must, however, be used with caution, as a low silicon and carbon, with high manganese gives hard iron and alters the shrinkage.

Spiegel Iron is used mostly in steel making. It is supposed to contain from 10. to 25. per cent. of manganese, but some authorities place the range from 3.50 to 20. per cent.

Ferro-Manganese contains from 25. to 90. per cent. of manganese. Most of the Ferro-Manganese on the market runs about 80. per cent. of manganese. With 80. per cent. of manganese present, there is not much room for iron. The metal, however, usually contains sulphur, phosphorus, carbon and silicon.

In cupola practice the amount of Ferro-Manganese used is generally very small, consequently the effect of the other metalloids is not great.

Manganese has a tendency to keep the carbon in the combined form; hence it lowers the graphitic carbon, thereby reducing the deflection. It neutralizes the effect of sulphur by reducing "red-shortness," and indirectly offsets the "cold-shortness" or brittleness caused by high phosphorus.

In foundry practice, the more manganese present in the pig, the more silicon and graphitic carbon required to produce soft castings.

For "chill mixtures," where great toughness is required, a pig with 2. per cent. manganese and less than 1. per cent. silicon is a desideratum.

No. 273—Malleable Bessemer Pig.

This specification will cover both the "common" and "straight" Malleable Bessemer.

When the "straight" Bessemer pig is specified, it is understood that the phosphorus is not to exceed 0.10 per cent. Straight Bessemer with 1.00 to 1.50 per cent. of silicon, about 0.60 per cent. manganese, under 0.11 per cent. phosphorus, and below 0.04 per cent. sulphur, will be satisfactory.

In "common" Bessemer the following limit will be specified:

Silicon,	may range from	0.70 to 2.10 per cent
	(Silicon of.....per cent preferred.)	
Sulphur,	must not exceed.....	.045 per cent
Phosphorus,	must not exceed.....	.15 per cent
Manganese,	may range from.....	0.30 to 1.20 per cent
	(Manganese of.....per cent preferred.)	
Total Carbon,	should not exceed.	..3.75 per cent

As a rule, the combined carbon will vary from 0.30 to 1.30 per cent., and the graphitic carbon from 3.45 to 1.80 per cent.

Preferred figures will be marked in red ink, and when specified, we expect to get an iron not varying more than 0.10 per cent. either way. When no preferred figure is specified, the silicon and manganese may be anywhere within the above limits.

The iron will be rejected if the analysis shows more than 0.05 per cent. of sulphur, or more than 0.18 per cent. of phosphorus.

No. 274—Charcoal Irons.

Charcoal iron differs from coke iron mainly in regard to the carbon.

The graphitic carbon appears to be in a finer state of division, and when changed into the combined form it produces a closer grain and stronger metal than does a coke iron with the same amount of total carbon. It is especially adapted to "chill work," and by regulating the amount of silicon and carbon, it is possible to get any desired chill.

The sulphur, phosphorus and manganese are quite constant in charcoal iron; the silicon and carbon vary to a decided degree, and these two elements will govern the various grades.

Graded according to fracture, there are usually seven distinct grades, designated by letters and numbers, and in some cases branded as "soft," "foundry," "medium," "high," "low," etc. (high and low referring to carbon).

Charcoal iron ranges in silicon from 0.30 to 3.00 per cent. The total carbon will run from 2.50 to 4.50 per cent., in some cases even higher.

In this specification we shall not specify any grade or number, but will ask for "preferred" per cents, as follows:

Silicon,	general total range... 0.30 to 2.75	per cent
	(Silicon of.....per cent preferred.)	
Sulphur,	must not exceed..... .025	per cent
Phosphorus,	must not exceed..... .25	per cent
Manganese,	should not exceed.. .70	per cent
Total Carbon,	general range..2.50 to 4.50	per cent
	(Carbon of about.....per cent desired.)	

Preferred figures to be marked in red ink.

"Low" carbon will be understood to closely approximate 2.50 per cent., "medium" carbon as 3.50 and "high" carbon as 4.50 per cent. or above.

Note.—Charcoal Iron gives a "chill" in accordance with the amount of silicon present, the other constituents remaining constant, or nearly so.

The following table is approximate, but near enough to give some idea of the effect of silicon on the carbon.

0.30	per cent	silicon is equivalent to	1½	in. chill.
.49	"	" "	1	"
.52	"	" "	⅝	"
.70	"	" "	¼	"
1.00	"	" "	⅛	"

Above 1.00 per cent. a chill may be induced by increasing the sulphur, or by altering the amount of manganese and carbon.

With manganese at 0.50 per cent. and sulphur at 0.095 per cent. in a mixture, the castings will take on a decided chill even with medium high silicon.

Sulphur increases, silicon diminishes, manganese toughens or stiffens, and phosphorus remains neutral in regard to chill.

A high carbon will give a hard, shallow chill, while a low carbon gives a soft, but deeper chill.

Chill is governed to a great extent by the cooling of the molten iron, different results being obtained by pouring against a large or small surface chill plate; also in pouring horizontally or vertically against the chill. A reverberatory furnace gives better results than a cupola in chilled work, due to the different effects on silicon.

No. 275—Phosphoric Pig Iron.

Phosphoric iron is used almost exclusively for small thin castings, where great "fluidity" is desired.

A very fluid iron is essential in thin work as it fills every part of the mold and gives a clear solid casting.

Iron high in phosphorus is very weak and brittle under impact (shock), consequently it can not be used where great strength is required. With high silicon and a high graphitic carbon, the phosphorus may rise to 1.00 per cent. in the casting, but in chilled work with low silicon and much combined carbon, the phosphorus must be kept below 0.30 per cent.

This specification calls for an iron within the following limits, viz:

Silicon,	must not be less than 1.50	per cent
	(A higher silicon preferred.)	
Sulphur,	must not exceed..... .055	per cent
Phosphorus,	should not be below 1.00	per cent
Manganese,	may range from..... 0.30 to .90	per cent
Total Carbon,	should not be below 3.00	per cent

Any car of iron showing on analysis more than 0.06 per cent. of sulphur, or less than 0.90 per cent. of phosphorus, will be rejected.

Remarks.—These specifications will be submitted whenever a purchase of pig iron is to be made, with the distinct understanding that there is to be no deviation from the figures specified.

No. 276—Specifications for Machinery Scrap.

Under this specification we desire a good clean scrap iron, such as Agricultural Implement and light Machinery Scrap.

The scrap must contain no wrought iron, steel, stove plate, grate bars, car wheels, brake shoes, chilled roll, etc.

Malleable scrap is objectionable, also excess of oxide or rust.

Large pieces, weighing more than 400 lbs. will not be accepted.

When a car of scrap is received, the inspector will superintend the unloading, and discard the following objectionable scrap, viz:

Wrought iron, steel, burnt stove plate, grate bars, car wheels, brake shoes, large chilled work, burnt malleables, and large pieces weighing more than 400 lbs.

Rejected scrap will be deducted from the

total weight of scrap received, and payment made only on accepted material.

No. 258—Specifications for Foundry Coke.

Under this specification we desire a good, clean, 72 hr. coke; as free as possible from coke dust and cinder.

The percentage of wall coke, known as "black heads," must not be greater than that usually found in "Selected" No. 1 Foundry Coke.

The coke should be of the massive form, and reasonably free from small particles, i. e., granulated coke.

"Structure" is an important feature, and will be considered when purchasing coke.

The structure of a perfect 72 hr. coke, should, according to theory, be made up as follows:

Cellular structure ....56.00 per cent.
Coke structure .....44.00 per cent.

We do not expect to get a coke with an ideal structure, but we do insist on a coke with a proper structure for cupola work.

Our castings are made according to specifications; and, as the iron is mixed by analysis, it is absolutely necessary that the coke be low in sulphur and phosphorus.

Well washed coke should not exceed the amount of sulphur herein specified.

When a car of coke is received it will immediately be sampled by an experienced man, who will select two average samples (ten pieces) of the coke from different parts of the car, and these two samples will be sent to the laboratory for a check analysis.

The coke will be accepted if it comes within the following limits, viz:

Moisture,	should not exceed..	1.50 per cent
Volatile Matter,	should not exceed..	3.50 per cent
Fixed Carbon,	must be above.....	86.00 per cent
Sulphur,	must not exceed....	.75 per cent
Ash,	may range from...	5.50 to 11.50 per cent

Coke will be rejected which shows on analysis:

More than 0.85 per cent of Sulphur.
More than .05 per cent of Phosphorus.
Less than 85.00 per cent of Fixed Carbon.
Less than 5.00 per cent of Ash.

These limits will be strictly adhered to and no concessions made in any case.

Note.—The Heinrich Method is used for all determinations in the proximate analysis of coke, except sulphur, which is determined by Eschka's Method.

When sulphur is included in an analysis, it is to be understood that the volatile matter carries one-half and the fixed carbon the other half of the per cent. due to this element.

The two following analyses of a "light" and a "strong coke will give a good idea of our method and statement of a coke analysis.

Both of these cokes are within the limits of the specification; No. 1 is a "light" coke and No. 2 is a "strong" heavy coke.

	No. 1.	No. 2.
Moisture	0.33 per cent.	0.49 per cent
Volatile Matter....	2.25 "	1.31 "
Fixed Carbon.....	90.54 "	87.46 "
Sulphur	.60 "	.72 "
Ash	6.28 "	10.02 "
Structure, cells....	52.94 "	50.04 "
Structure, coke....	47.06 "	49.96 "
Specific gravity....	1.697	1.890 "
Heat units (per lb)	13540.	12037.

No. 1 is a light coke with medium porosity, and will give a quick intense heat.

No. 2 is a strong coke, and will hold up a heavy burden of iron; the porosity is lower (i. e., the coke is more dense), consequently a stronger blast is required.

A strong, heavy coke will give a steady continued heat.

(TO BE CONTINUED.)

Physical Characteristics of Malleable Cast Iron.

The advantages and necessity for uniformity in malleable, when the same is to be used in castings subjected to the frequent and non-equal strains incident to their locations on machines, railway cars, etc., and developed under so many dissimilar circumstances, combined with varying temperatures, make the question of physical characteristics one of great moment. Until within a few years ago the best guide, with reference to quality, has been the cold bending tests given after annealing, and if metal has proved soft and malleable under these tests the material was accepted as successful. This test is still, for a great many purposes, a most reliable one, when light castings are being considered. With heavier castings, however, when diameters are ¾ inch and over, it has been rather difficult to produce satisfactory cold bending tests, the main stay being in such cases the appearance of fracture after cleavage break or shear; and it is with reference to the latter class of castings that physical tests are most applicable. As all heavy castings are subjected to their service requirements when

cold, it will be recognized that only in rare cases have they been called upon to withstand service involving any noticeable deformity in original lines.

The successful casting is one which will withstand such service and still present the same lines as before. The material need not be so high in tensile strength to accomplish this end that malleability should be sacrificed. Malleability in heavy castings does not convey the same meaning when comparison is made with light castings. In light castings it is a soft, pliable and contortionable condition. In heavier castings it is the ability to receive shocks and blows without breaking or bending, and this in no degree means excessive tensile strength or excuses shortness and hardness. The questions are often asked, What will your iron stand? What can be done with it? Will it bend back upon itself? All are quite natural questions, but when speaking of heavy work they do not exactly fit the case. Nor is the M. C. B. drop test for draw bars a satisfactory test for quality. There have been couplers known to stand a number of blows in excess of the prescribed specification, but in service the group represented by the tests has failed signally. There is certainly some patent cause for this, not easily explained. The perfection reached in open hearth steel casting is directly due to the lines drawn relative to chemical and physical limits. There are as yet no specifications for malleable touching either, although one railroad in the East has designated the tensile strength desired in its castings. It is a question whether malleable concerns are prepared at the present moment to guarantee their product following somewhat these lines, as there has not been that liberal usage of the laboratory and its accompanying advantages to warrant confidence in each succeeding heat poured. But it is believed that the near future will find all prepared to welcome specifications.

There will be no greater incentive possible to any concern than the knowledge that they are working to "limits." As it stands to-day, the make-up of metal varies with every individual concern, and, while thoroughly reliable for local usages, suffers by comparisons in the interchange of parts sometimes necessary in railroad practice. With the advent of restrictions will come the uniform shrinkage so eagerly wished for at present. A physical test for malleable iron which calls for more than 45,000 pounds does not guarantee the ideal metal for railroad work. It will possess that doubtfully beneficial strength which shows to great advantage upon reports, yet has in it an element of hardness which precludes the possibility of long service. Physical testing is just beginning to attract the attention due its importance, and perhaps the delay in this matter has been caused by the fact that malleable, like steel in the past, has now passed through all of its experimental phases. The idea of physical specifications is very new, but it will prove a most excellent ground gainer to the careful manufacturer, whose pride in his output amounts to a question of honor. With the adoption of physical standards will arise the necessity of employing chemists in all works, for the effects of the metalloids upon physical characteristics are well marked. It cannot but prove to be a source of great satisfaction to careful producers, for they will be guarded with a bulwark of safety. The malleable casting of to-day is one of the greatest offerings in the whole iron industry, representing as it does many long years of patience in perfecting it, and yet the real work is only begun. There are many concerns making good malleable, and not a few better than before. The reason seems quite obvious. A few years ago chemistry was adopted into the malleable art and was stamped a great thing, but in some localities it was not entertained with the respect due its worth. Questioned and suspected at all points, it was finally discontinued, with the result that some firms have gained nothing whatever from the experience, while others are enjoying the undeniable benefits procured by judicious management. The future development of the malleable casting must be along the lines of chemical and physical testing.

The heat treatment of metal during melting and annealing has a very important bearing upon its developed tensile strength, elongation, etc. The generation of excessive temperature always promotes the chances of burning, and while metal may be burning the chemical aspect changes but little, while the molecular composition is receiving a shock from which it never recovers. What is burnt iron? And why does iron become

susceptible of burning? These are seasonable questions upon which there has been considerable discussion and many theories advanced, yet there are many skeptics upon the subject. Iron is burnt mainly through the generation in melting furnaces of higher temperatures than those prevailing during the initial casting at blast furnaces. Superheated metal is always to be feared regarding quality. When a heat is charged in which all the metal is "low" or high silicon pig the opportunity for burning is not as great as in heat charged in which the metal is "high" or low silicon. The first mixture has an element of contained heat to balance heat of blast while melting, but the latter has no resource in this direction whatever. If these heats were charged following each other there would be, nine out of ten times, no changes possible in the method of firing, consequently no great variance in heat of furnace, and yet there should be some counteracting agency at work in the high mixture to offset excess heat of the low mixture. Superheated metal, or metal not high enough in silicon to hold fluidity, is readily discernible in ladles by the rapidity with which it sets. This metal will in the physical tests show considerable tensile strength, but a small percentage of elongation. This latter is due to the fact that the "clinging" propensity of the molecules has been injured beyond redemption. There is no tearing of the metal in testing machines previous to the break; it "goes" all at once, and there is that omnipresent heavy white edge to characterize it. The mixture high in silicon should obtain its tensile strength from its silicon-carbon content and elongation from the undisturbed state of its molecular condition. The mixture low in silicon should receive its tensile strength from the density of the molecules and its elongation and reduction of area from the low carbon content.

When the heat of blast through the melting furnace is too strong, owing to an excess volume of air being introduced, the metal after melting will start to oxidize. This metal upon reaching its crucial stage will then be in condition to burn readily, having already exhausted considerable of its reserve qualities. It will be readily seen that this condition will affect the tensile strength most naturally.

The very choicest irons thus turn out poor material; whereas, if the heat had been allowed to "come up" slowly, we could have anticipated the best results. A well calculated heat will (unless something unforeseen occurs) invariably produce excellent results if worked slowly.

The action of the annealing ovens is also well defined in this direction. Whether the fuel used be coal, coke, gas or oil, the result will be the same if heat is brought to its highest point before the metal is ready to receive it. Burnt iron in the anneal is no uncommon feature, and, generally speaking, it is the result of carelessness. The real value of the annealing department is very often overlooked. It is often in charge of men whose compensation is low and who (to their credit must be said) do their work, as a rule, in proportion much better than their companion foremen of other departments. But here, as elsewhere, there has not been that confidence in their work which should guide them. They work by precedent, and ask no questions. The theory of the anneal is sometimes a ticklish one with them. The most carefully prepared metal from melting furnaces can here be turned into worthless castings by some slight inattention of detail. The highest point in temperature for the annealing should be registered in each foundry, and kept there by the daily and frequent usage of a thermometer constructed for that sole purpose. The uneven workings of furnaces accounts for many a batch of rejected castings. These latter conditions are more likely to occur in plants where coal and coke are used in ovens, as it is simply impossible to regulate heat under these prevailing circumstances. With oil and gas the danger is greatly removed, and, barring occasional changes in pressure, the heat is uniform. Changes in the heat will at once affect the quality of iron. Steady, continued heat insures soft castings, while unequal temperatures destroy all chances for successful work, though the initial metal was of the most excellent quality.

The question as to the effect for good of charging the packing with sal ammoniac is at the present moment being agitated very generally, and it is with some hesitancy that the writer expresses himself. There are some concerns who never charge their packing, and claim as beneficial results as those using the prepared packing. They claim

that there is nothing which anneals but heat. However, fact is fact!

The experiment was tried, and most successfully. One set of test pieces was taken and packed in "dead" packing and the other in "charged" packing. These bars were poured in each instance from same heats, from same ladles and in the same molds, and were packed in furnaces with the heat conditions alike for both. With packing charged in some manner the castings will be softer, having more elongation and greater reduction of area.

UNPREPARED OR "DEAD" PACKING.

No. of test.	Total carbon, hard iron.	Total carbon, soft iron.	Tensile.	Per cent. Reduction of area.	Per cent. Elongation in 6 in.
3812	3.23	3.01	48,600	0.37	6.16
3831	3.39	2.92	47 400	0.30	5
3851	2.97	2.90	46,800	0.27	4.50
3861	3.10	2.90	47,400	0.31	5.16

PREPARED OR "LIVE" PACKING.

No. of test.	Total carbon, hard iron.	Total carbon, soft iron.	Tensile.	Per cent. Reduction of area.	Per cent. Elongation in 6 in.
3812	3.23	2.90	48,900	0.43	7.16
3831	3.39	2.81	45,600	0.33	5.50
3851	2.97	2.72	48,600	0.36	6
3861	3.10	2.82	45,900	0.34	5.83

These tests show unmistakably the treatment due a physical test by proper handling of annealing department. Be not deceived. It is true that without preparation of the packing the annealing may be carried through, and the appearance of the castings for months may not vary, but they will not be soft. And in the case of prepared packing the identical same test bar gained from 1 to 1½ per cent. in elongation in all cases. The discontinuance of charging packing is an economical move with reference to handling work cheaply, but in the instance of heavy work it is costly practice in the end.

That the chemical components exert a powerful influence upon the strength of iron is an assured fact, though not as fully understood in the case of malleable as with gray iron and steel. The metalloids most injurious would be singled out by the proposed specifications and limits placed thereon. Here again will that ever prominent feature of heat conditions assert itself. The metalloids occurring mostly in pig iron may be grouped with reference to their peculiar effects upon the physical showing of tests, and thus we would have in the finished metal silicon, manganese and graphitic carbon working together for the strength, and sulphur, phosphorus and combined carbon affecting the tensile strength. With silicon and manganese in their certain and relative proportions there can be no doubt of their beneficial action toward strengthening the product, and almost, it may be said, when in excess to the point of "shortness." Very often the metal has shown in tests and finished castings a steely fracture, and almost invariably has the same been explained by the presence of too much silicon. Chemical research has also demonstrated it. When the silicon is about 0.75 in finished metal it will show higher tensile strength and less elongation, for the reason that had the same mixture been properly worked the silicon would have been reduced, but now it resembles, after a manner, gray cast iron, with its correspondingly high silicon content. With this high silicon comes a resulting condition—namely, higher carbon in the graphitic state. There cannot be a high silicon and low carbon in material, as these two elements must act jointly in eliminating each other. The low silicon-carbon content must be maintained when calculating heats in which strength is desired. Silicon holds the carbon in certain ratios, as in the making of steels. That low total carbon is the secret of attaining reduction of area and elongation is demonstrated beyond a possible doubt. In the following tests there will be found some of these facts demonstrated—namely, with low silicon and carbon comes the reduction of area and elongation:

No. of test.	Silicon.	Total carbon.	Tensile	Reduction of area.	Elongation in 6 in.
219	0.62	2.20	47,350	3.27	5.33
227	0.51	2.40	48,960	3.42	6.50
228	0.58	2.32	45,370	4.33	5.83
231	0.47	2.07	42,050	4.83	7.83

Manganese in the latest practice is kept high, mainly with reference to the combining of carbon in the hard iron, with that easing off of liquid shrinkage so prevalent in the older working. In the anneal manganese stands practically unaffected by the heat generated there, and so is an element of strength all through. The reduction of area and elongation are the direct results of low carbon. It is simply a metallurgical impossibility to have the reductions, etc., with a high carbon content. With sulphur and phosphorus comes a weakening of malleable.

Their action and effects are clearly drawn, both having a hardening tendency, making metal stiff. Often in malleable foundries castings containing carbon in the graphitic condition are passed through the hard iron inspection to anneal, and these castings show high tensile figures, but with small reductions. To obtain an iron which will work under the hammer while hot, and without cracking (this is a very trying operation) there must be this low silicon-carbon-phosphorus feature. Malleable iron with high carbon will not bend back upon itself. The following figures are from heats in which these negative features have been prominent:

No. of test.	Per cent sulphur.	Per cent phosphorus.	Total carbon.	Tensile.	Reduction of area.	Elongation in 6 in.
220	0.052	0.272	2.72	49,500	1.07	3
242	0.061	0.197	3.01	49,000	1.23	2.33
247	0.047	0.216	2.42	47,620	2.02	1.83
248	0.058	0.172	2.67	51,000	0.82	1.50

The most destructive features of high sulphur and phosphorus are the small cracks, like incisions, over the surface of castings. In physical testing these cracks play a considerable part in the question of elongation, too small at times to be seen; yet the stretch of the metal taking place in these apertures leaves no great elongation in the metal. The combined carbon in annealed castings, which is, in most cases, very low, still has a hardening effect. Though not prominent, it still contributes. A very beneficial move was made some time since by a blast furnace management in Ohio, when they put a burden of selected ores in stack and cast the iron into iron chills. This iron was ideal for malleable, having a low silicon-carbon content, with phosphorus and sulphur in reasonable limits, and was a great step forward toward the end hoped for in coke iron. But at the time of its initial appearance it was not taken up with the favor it should have received, and was therefore not appreciated, being thought premature. A heat of this pig metal under the writer's observation developed the following remarkable results: Forty-seven thousand pounds tensile strength, 4.33 per cent. reduction of area and 8 per cent. elongation. Stiffness with malleability. It was a distinct move in the right direction toward uniformity of material.

In considering this topic we will call the heat test—i. e., the test made at the furnace to determine whether carbon is in combination—a physical one, and the endeavor will be made to demonstrate that this test, while carrying great weight as to the condition at the point of pouring the metal in the furnace, does not possess the necessary reliability and does not, strictly speaking, furnish a fair criterion of the metal. Here again is encountered a heat condition. A furnace charged with 10 or 12 tons of metal, and taking from one-half to three-quarters of an hour to run out, according to the size of the tap hole, cannot produce metal which may be called uniform. As soon as metal has been brought up to its highest heat, carbon being in combination, the quicker it is gotten out of the furnace the better will be the ensuing products. After the highest heat point has been reached the continued blast necessary to maintain the heat in the metal to a suitable point for pouring works havoc with those chemical metalloids which affect fluidity, but, on the other hand, enhances the chance of a better iron physically by serving to reduce the carbon and silicon. Thus it will be seen at a glance how impossible it is to rival open hearth steel regarding uniformity, or even, in many cases, a well managed cupola on gray iron. In open hearth steel practice, when carbon and silicon have been reduced to a certain specified point, the "heat" is drawn in bulk and there is no further chance for a chemical or molecular change. In gray iron cupola practice new raw material is constantly coming in contact with fuel, and insuring, in a way, the continued grade of metal at point desired. In the air furnace, on account of the length of time the liquid is kept in contact with the flame incident to pouring, it of necessity affects the molecular conditions, and in the case of pouring heavy castings (and this is the class of work being considered under this heading) the last iron out is better than the first. There cannot be a doubt but this fact accounts in a measure for the variations met with in material after the anneal.

In heavy work mixtures the first metal poured from the furnace will be "softer," or higher in total carbon, consequently inclined to be of an open grain, and the last metal is denser, being lower in total carbon, etc. That there is a marked and influencing difference between extremes of heat (from the moment the metal is tapped until run out), which explains many breakages, is clearly

demonstrated by tests here submitted, taken in each instance from same heat at extremes:

FIRST IRON.

	Total carbon.	Silicon.	Tensile.	Elongation in 6 inches.
261	3.52	0.91	46,500	4.33
263	3.37	0.72	52,000	3.37
265	3.42	0.68	49,000	2.93
267	3.29	0.89	43,000	3.33

LAST IRON.

	Total carbon.	Silicon.	Tensile.	Elongation in 6 inches.
261	3.23	0.62	42,700	6.16
263	3.09	0.68	45,000	5.23
265	3.27	0.62	42,000	4.27
267	3.07	0.72	42,000	3.33

In keeping this idea of desired uniformity ever before us, the question naturally arises, How can the result be otherwise, using the present reverbaratory furnace? With light work mixtures the differences are not marked to any great extent. In heavier work there is a remedy, and one tending toward a possible solution of the question. It has been the writer's privilege for two years to have charge of several Simens-Martin acid open hearth furnaces producing malleable iron, and during that period he had great opportunity to study the problem in hand, and believes that thorough uniformity is possible and necessary.

Owing to a peculiar foundry construction, it was not possible for the molders to catch the metal at furnace spout, and it was not practicable to carry metal to them in "bull" ladles. Therefore, the whole heat of eight tons was tapped into a previously heated ladle and conveyed by electric crane to a suitable place in the foundry for pouring. The tests at the furnace were made until just the point desired was reached, and then the furnace was tapped. In less than one minute the contents were in the ladle away from any possible further chemical or molecular change. This metal was uniform! The results of this peculiar practice gave the castings thus produced a great prestige over the ordinary air furnace metal. The physical tests were most encouraging. The adoption of this style of furnace in malleable works would be a most radical change in founding, though not practical in present erections. But with the necessity of a better and more thorough refining of coke irons this idea is brought forward as possibly an outcome of the situation. The most satisfying feature about it is that it is no experiment. Here we have at this early day a thoroughly advanced material claiming the attention of more thoughtful producers.

Some of the physical tests are remarkable and show to great advantage the points mostly desired in railroad castings:

Number of test.	Tensile	Reduction of area.	Elongation in 6 inches.
A	52,000	6.42	7.33
B	49,000	10.12	6.50
C	48,000	11.12	7.00

The appearance of hard iron tests are forerunners of the quality of iron after annealing. Seen under the magnifying glass are many peculiar phases, all of which have directly traceable bearings upon the resultant product. In the light work mixtures the tests show a distinctly rough and disjointed condition of the particles, owing to the fibrous nature of the metal when in hard iron, and, having a high carbon content, break with toughness of original pig metal, there being in such instances but a small loss in carbon. After annealing, this metal, which in the hard iron was so tough, is now lamentably weak, owing to this excessive high carbon.

In the tests for heavy work mixtures the microscope reveals an entirely different aspect. There is that crystalline glacial formation, converging toward the center, owing its formation to the intensity of cooling strains, and which in many cases when iron is run too "high" causes castings to crack. Then, again, is found a test, with crystals as large as in a No. 3 iron, having a black circle around its edge. This almost invariably comes from a higher percentage of sulphur which has combined carbon higher, relieving somewhat the internal strains. A test piece 1 inch in diameter will show a complete combination of the carbon, but one 2½ inches in diameter, poured at the same moment from same ladle, will show graphitic carbon in bulk. In cooling tests in hard iron, preparatory to tapping out, the test will, if the carbon is combined, crack with a distinct ring; whereas, if there was graphitic carbon present the latter would assemble in small groupings, holding the metal together and resisting the action of water. The most satisfying test in hard iron is the "wedge," giving, as it does, an early criterion of the capabilities of the heat. This test acts not only as a physical test, but also serves as a fluidity guide. When carbon is only about one-half combined with the iron, and two large tests should be poured, one of which will be cooled with water and the other allowed to cool by itself, the former will show small

and regular clusters of graphitic carbon remaining, while the latter will resemble very closely a light colored gray iron, the crystal groupings being very dense. This latter condition arises entirely with the heat remaining in test for a considerable period, thereby holding that proportion of graphitic carbon remaining in suspension. In the test cooled with water the graphitic carbon, being in excess of the absorbing qualities of the iron at that particular point in heat, has been driven into the small group, as before described. These above mentioned phenomena occur mostly when the silicon content is high, particularly in light work mixtures, and show to great advantage the altering phases of carbon. Carbon is never thoroughly combined with iron until the silicon has been greatly diminished. A high percentage of silicon will hold carbon in suspension, preventing the combination so essential in heavy castings. In light work, with its high silicon and carbon, metal is chilled and carbon is combined by contact with damp sand. In malleable cupola practice this is about the only method of affecting carbon, there being practically no molecular change possible in cupola while melting. A low total carbon and silicon—a certain percentage of sulphur being present—has the effect of giving test pieces their very close fracture, resembling the high state of glacial crystallization found in No. 6 or No. 7 iron. Higher carbon and silicon and lower sulphur keeps the test pieces gray for a continued period, necessitating higher heat in furnace, while at the same moment affecting the life of fire brick in no small manner. The malleable casting, when cast, is subject to both internal and external strains, according to section. The malleable draw bar with surface chills and hard cores has been relieved of many detrimental features But with the lighter castings and patterns of unequal diameters there is always the likelihood of cracking under casting strain. There are several safeguards against this trouble; one of the best is the usage of small quantities of aluminum in ladles.

There have been many shapes under personal observation which, when molded, presented a great question regarding best method for saving same when cast, the only resource in some cases being a cooling down in a previously heated furnace over night.

If there is to be any possibility in the future for uniformity in malleable castings there must be adopted some general method of testing, which will be broad enough to cover the inequalities of comparative workings. To sell malleable under chemical and physical classifications is, at the present moment, an impossibility. This also was the history in steel casting for many years, but with far-sighted experiment the point has been reached when producers may guarantee their metal with safety. The adoption of a test bar for general use could be decided by some discussion. We believe, however, that it should be exactly 1 foot long, and when molding a chill should be placed upon either end, to thus attain the greatest shrinkage. A micrometer reading should then be made of bar before annealing and shrinkage for shop practice established. Malleable concerns making agricultural shapes, etc., cannot afford to deviate in their founding practices as castings which are supposed to fit snugly over other shapes must be made of metal in which the correct amount of shrinkage is assured. When metal is said to shrink ⅛ or 3-16 inch to the foot it is understood that this is hard iron shrinkage in all cases. The metal in annealing expands, and finished product shows rarely over 1-10 inch shrinkage from original measurements, bringing it finally close to gray iron shrinkage.

To illustrate above statements, the following figures will prove interesting, one set showing hard iron shrinkage and the other set the shrinkage found after anneal, the test bar being exactly 1 foot long:

Hard.	Soft.
0.225	0.090
0.225	0.100
0.235	0.125
0.237	0.087

The above figures represent a very fair working, no freak heats being considered in figures given by writer. A very convenient form for the bar is a round section which figures about ⅓ square inch. The square bar is absolutely without one redeeming feature when considered for malleable work. The pattern should have 6 inches in the clear in center and be enlarged towards ends for the grips of the testing machines. In molding bars the gates should be cut upon the side of the bar near the ends, but not on the

ends. The pattern should be well proportioned, bringing the larger end sections to meet the smaller middle section by an easy gradation, thus avoiding the shrinkage in bars which causes them to break in the grips of the machines. With the present air furnace practice test bars should be poured as near the middle of the heat as is possible. The number of each heat being cast upon the end of the test bar, will, while following the physical results, also furnish a reliable guide in determining the chemical composition of any heat desired. The test bar is the surest method of following a heat's working through the process. The matter of having bars tested brings the matter down to a question of local coloring. Many concerns will argue that the physical test is not of enough importance to them to warrant purchasing a machine for their use. Physical testing is a recognized necessity with all the larger concerns producing railroad castings, and these works will have their own apparatus A very good plan for smaller works to pursue would be to make some arrangement with parties having machines for a test at least once per week.

Riehle Bros., Philadelphia, manufacture a small machine, 50,000 pounds capacity, which is ideal for malleable works. Since the test bars are ⅛ or ½ inch diameter the capacity is far beyond any possibility in the metal. This machine, when connected with a 1 horse-power motor, is very convenient.

There is not one branch of the iron and steel industry, with the exception of malleable cast iron, which has not undergone some very radical changes in mode of production during recent years, and all have proved to be benefits physically. With the tightening of the iron market and loss in choice of buying iron, the producer finds an awkward situation to face in the maintenance of uniformity in castings. There must be a new malleable furnace projected ere long. The moment is more than ripe for its introduction, and when it does come may it combine some slagging and absorbing features with its melting hearth. The inability of the individual blast furnaces to procure desirable lake ores, by reason of the absorption of these mines by the trusts, compels the smaller furnaces to depend greatly upon local ores for their main stay. These latter ores are so high in objectionable impurities that they make the iron (being used in such a branch as the malleable, where every impurity is under suspicion) a quite undesirable factor in burden. There is no bad or worthless pig iron. There is a method of using it all, irrespective of its inferior quality. We all recognize how hopeless it is with present constructions to eliminate sulphur and phosphorus. There seems no escape from the metalloids. And it is also recognized that great benefits physically would result with their absence. The silicon and manganese are distinctly controllable, or ought to be, with good judgment. As in the instance of silver and gold, we do not wish for a pure iron; that would be a weak affair, and so, therefore, a reasonable amount of alloy of the right kind is desirable. There will be many objections raised with the withdrawal of phosphorus as detracting from fluidity, but all these seeming stumbling blocks will be readily overcome with careful experiment. With a prepared lining and the employment of a flux this anticipated furnace will revolutionize malleable methods. There is no doubt that the annealing will be shortened in no small manner. The writer places great confidence in the idea that this proposed melting hearth will be modeled after the Siemens-Martin. Producer gas is so readily controlled and heat conditions so uniformly alike that here, as nowhere else, seems the possible outcome of the new furnace. This new idea iron should show a tensile development of 42,000 pounds, with an elongation averaging 6 per cent. in 6 inches. The unquestioned feature of uniformity will commend itself at first glance, knowing, as we do, the difficulty experienced in present furnaces to produce succeeding heats like former ones. The feasibility of the basic open hearth to handle malleable is not doubted. It has been melted successfully in the acid open hearth, and the basic is but a step further on. The field, now debarred, which the introduction of the proposed furnace would open is as large as that attending the development of radical changes in other branches of the art. Irons which are now distinctly off grade could be reclaimed and put into market on a par with those of known higher gradings. Foundry irons with phosphorus at 2 per cent. and over could be worked without any trouble whatever. No matter how high the per-

centage of impurities may be, the metallic iron is as pure in a foundry iron as the highest grade Bessemer open hearth pig irons, for if the impurities are removed the resultant metal cannot but be good. The possibilities of this proposed furnace for handling malleable are as yet to be developed. There will be some opposition to overcome by projectors, but the end is assured as certain. It should commend itself to careful managements as a great step onward toward the betterment of a now sometimes uncertain quantity.—E. C. Wheeler, in Iron Age.

Commenting on Mr. Wheeler's article, Benjamin Talbot writes as follows: I notice Mr. Wheeler refers to the use of a basic lined furnace for refining the iron and states that the time is now ripe for some such improvement in this branch of the iron trade. It may interest him, and possibly other malleable iron casting manufacturers, to know what has already been tried in this line.

In 1891 the writer put a basic lining in the air furnace of the Chattanooga Malleable Iron Works and ran it for some time. This was done so that Southern coke irons, which contained too much silicon and phosphorus for the ordinary acid hearth, could be used. Excellent malleable iron castings were obtained, but the fact was developed that the ordinary air furnace was not suitable for a basic lining made of shrunk dolomite, if it was to be chilled off everyday after tapping.

The metal changed and became refined more rapidly on the basic than on the acid hearth. In fact, with heats of 8 or 10 tons run through a small tap hole and caught in hand ladles, as now practiced, the last half of the metal would be refined too much and become too sluggish to pour the castings successfully. This difficulty was encountered with 6 tons of metal and led the writer to suggest that steel works practice be adopted, so that the metal could be tapped rapidly through a large hole into a ladle. This was done and the metal was successfully repoured from the storage ladle into the small hand ladles and from them into the molds.

A few years later a basic lining was put into Stanley G. Flagg's foundry in Philadelphia, and the experiment tried here again indicated that it would be necessary to abandon the present system of hand ladles used in emptying the furnace and substitute a large ladle, so that the metal could be run from the furnace rapidly. It is possible that with the basic material now available better results (as regards the wearing of the hearth) may be obtained with the present crude and extravagant form of furnace, but in the writer's opinion a gas furnace with air regeneration will prove to be a great economy, although much more expensive to build.

If large malleable iron casting manufacturers desire to reduce the cost of their present method and are not afraid of the necessary capital expenditure, they have only to consult the people interested and study the process now used in a large basic steel works to find out that a process and furnace is already developed which is eminently suitable for their trade. This process is a continuous one and requires a tilting furnace to obtain the best results. Liquid metal is also required if a large output is desired from one furnace, so that in the absence of suitable liquid blast furnace metal a cupola would be necessary to melt the pig iron. The method of operation is as follows: A tilting furnace of about 15 tons' capacity when filled would be installed. In this furnace a heat of 10 tons would be refined to the desired point necessary to make the castings. Instead of pouring this out into the ladle 5 tons—preferably of liquid metal—would be added to the refined liquid metal in the bath. The silicon in the added metal ought to be at least twice as much as the refined metal in the bath. The result would be that the impurities in the 5 tons would be immediately reduced by mixture alone, and the action of the oxide of iron in the slag would rapidly bring the silicon and carbon of the entire bath down again to the point required for good castings. As soon as this condition was obtained the furnace would be tilted and 5 tons poured out and the operation just described again repeated. Slag would be flowed away from the furnace through the slag spout as often as desired and slag forming additions would be added when necessary.

A furnace working under such conditions, if charged with liquid metal instead of solid, would make 5 tons of refined metal in about

one hour. It could be purified in much less time, but the question of the necessary degree of fluidity must be considered and can only be ascertained by actual practice. If the added liquid metal contained considerable silicon it would add heat to the bath by its oxidation. This would mean an output of some 35 to 40 tons of refined metal in a shift and would necessitate continual pouring into the molds all through the day. The furnace would also have to be kept hot and charged with solid stock during the night, so that the bath would be ready to receive the liquid metal for the next day's work. A furnace of larger or smaller capacity would of course increase or decrease the output in the same ratio.

I notice that it is suggested in Mr. Wheeler's article that any class of pig iron could be used with the basic lining, even if it contained 2 per cent phosphorus. I am afraid that this is an erroneous conclusion, as my experience with the basic process proves that such metal could not be used to any extent in the mixture for malleable casting purposes. Iron containing 2 per cent phosphorus is used in the basic open hearth steel process, but the phosphorus is only entirely eliminated where the metal has passed the refined cast iron stage and become steel. Phosphorus and carbon are expelled together in a basic furnace when covered with a suitable liquid basic slag.

A basic lining will enlarge the sources of supply of pig iron for the malleable casting trade, as the phosphorus and sulphur can be reduced, which is exactly the opposite to what is occurring in the present practice. In other words, phosphorus constantly increases in the acid hearth from the waste of iron due to the remelting and oxidation from the air blast. This is rectified by using pig iron containing less phosphorus than the sprues and defective castings remelted.

The writer believes that the value of the basic lining to the malleable casting trade will be in the use of coke irons of more or less irregular silicon contents and with less than 0.30 phosphorus and doing away with charcoal iron entirely, unless this competes with the other in price.

Whatever the future may bring forth, Mr. Wheeler will be found to be correct in his advocation of a basic lined gas furnace as being the next step forward in his trade.

Strike Epidemics in the Old World.

The United States has had its surfeit of strikes, and is still gluttonous. Europe is having a full diet of the same, and industrial ruptures are as common as coughs and colds. It is estimated that in three months of the present year, not less than 9,000,000 working days have been lost to labor and wages. France, according to a contemporary, has by far the largest number of difficulties to settle, while Great Britain has had the largest number of men involved in strikes. There are all kinds of reasons and causes, some serious, some trivial, and others of the fad and foolish type. In France, for instance, the cabmen in Paris struck for the reason that the Exposition had failed to keep them busy. The postmen also registered a kick at having too much to do, and conscientious gun makers of the Creusot Company objected to the manufacture of implements of warfare, as being auxiliary to man-murder. The stokers on transports had their special grievance when the trouble with China began. By the authority from which we quote, of nearly eight hundred labor organizations in France, eight per cent of the members are out of work, and at the present time over 20,000 persons are either striking or are locked out over labor differences. Spain has a big bunch of nettles to handle, and Holland and Belgium are by no means in a condition of industrial harmony. In Germany and Austria-Hungary the monthly average number of organized workers on strike is about 15,000. In Great Britain—the fighting arena of labor troubles—strikes are as common as umbrellas, and organization is so well systematized that a strike is almost a national calamity. It is true that all possible remedies have been devised and applied, but trade-unionism, for good or evil, has its hands on the throat of the nation. It pervades all trades and industries, from the mechanic who objects to labor-saving machinery, to the hotel waiter who has taken a sudden dislike to "tips" and now demands a revised schedule of wages to make up for the lost sixpences his conscience forbids him to touch. Even in Porto Rico, Japan and other countries, the strike has come with western civilization.—Age of Steel.

And sometimes it is the small shop, without equipment, which fixes the price of castings.

Chester's Steel Industries

One of Chester's characteristic industries now, a feature by which it is best known in the business world, is the manufacture of steel castings. The business has centered here and Chester has become headquarters for the trade in the eastern section of the country. There are four large plants in operation now, and a fifth, the new Seaboard, is now so nearly completed that the company are booking orders for December deliveries. The main foundry building is practically completed and is one of the most imposing structures along the Delaware river front, being 560 feet in length and 110 feet wide. The machine shop, boiler and power house and producers for making gas are all covered by another large building, 380 x 100 feet, running at an L with the foundry. The buildings are all of steel, with brick side walls and slate roofs. The boiler installation is completely in place and ready for making steam, and the gas producers are nearly finished. The two large open hearth furnaces are well under way, and the cranes are being erected in the foundry. There will be ten cranes, ranging from 10 to 40 tons capacity, in the foundry, and the plant is so arranged that castings can be delivered directly from the foundry to the machine shop without being lowered from the cranes carrying them. Both the Pennsylvania and Philadelphia & Reading railroads have tracks in the Seaboard Company's yard, and the new wharf being constructed goes out to the deep water channel in the Delaware river. The company are operating their own gray iron foundry, making castings for their own purposes. It is understood that large purchases of steel scrap and other material have recently been made on this company's account. The Seaboard Steel Casting Company were incorporated in March last, and have a capitalization of $500,000, fully paid. It will be one of the largest steel casting plants in the world when finished.

The main office of the American Steel Casting Company, the largest manufacturers of steel castings in the country, is located here. This company have plants in Alliance, Ohio; Pittsburgh and Sharon, Pa., in addition to the Chester plant.

The Penn Steel Casting Company, the Chester Steel Casting Company, the Solid Steel Casting Company, succeeding the old Eureka, are likewise located in this city.

The steel foundries now in operation, employ about 1,200 men, and the new Seaboard will increase this number to probably 1,500; so it may be seen how important the industry is to Chester.

The active open hearth departments at this time in the city are the Tidewater Steel Company, with four 50-ton furnaces for ingots, not for steel castings; American Steel Casting Company, with two furnaces; the Solid Steel Casting Company, with one furnace; Chester Steel Casting Company, with two furnaces, and the Penn Steel Casting Company, with two furnaces.

Founding in the Ozarks.

On a recent visit to the town of Hot Springs, Arkansas, I met two prominent molders, one a Mr. Gallagher from Cedar Rapids, Iowa, the other a Mr. John Farrell from Butte, Mont., and having been there several days without knowing that there was a foundry in the town my attention was drawn to the fact by my two friends. They posted me as to its location, and one day I set out to see it all by myself. Upon reaching it I remembered having passed that particular spot several times without suspecting its character, there being no cupola stack visible. The building stood back about 75 feet from a high picket fence, just at the base of the Ozark mountain. On entering the gate I noticed the yard strewn with different kinds of scrap iron. A stable containing a cow and a horse stood close to the gate.

On reaching the foundry door I observed that there were no molders at work, instead one man was working at a vice, another at a forge. After taking a general survey of the place, I concluded it was all home made, and "hand picked." The man at the forge proved to be the proprietor, as I learned from the man at the vice. The latter was a Texan, and wore the regulation Texan uniform, consisting of a brown blouse, a pair of blue overalls tucked in his high-heeled boots, the whole being topped off with a large white hat. After shifting the cud in his mouth and expectorating on the dog that lay near his feet, he inquired of me: "Air you a molder?" I replied that I was; "then I reckon you kin git a job hyer bekase the

ole man's got some machinery to make." Just then the old man ordered him to go and hold the cow for his wife, who appeared at the foundry door with a milk pail in her hand, and hitch up the horse after he was through. In conversation with the old man I learned that he was an all around man, made his own patterns, shod horses, repaired wagons, etc. The Texan was the only molder, and he had only been in the business five months. The principal work was sash weights, and grate bars. He done some of the molding himself, run the engine (which was about eight dog power) and the cupola, and said he had built the latter himself. The coke and iron were carried up a step ladder in baskets, and was charged from the top.

Some flasks of sash weights were molded up on the floor and three little children were enjoying themselves by playing tag among them. Several chickens were picking around in the foundry also, and the old man went and shooed them all out when one got on top of a mold and began to scratch.

He spoke about an order of two columns he was just after finishing. They weighed about four hundred pounds each, and he said he had an awful time getting them out. The pattern was a pine tree cut down from the mountain side, and that part of the trunk that came nearest to the dimensions of the order was cut out, the bark peeled off, a base nailed on one end, and a head on the other. Just then the Texan drove up with the wagon, and loaded up some of the products, and he, together with the old man, drove away to deliver the goods.

C. RITIC.

Some Patents Which Have Recently Expired.

BY A. E. FAY.

No. 272,808, granted to O. E. Weatherhead on a composition known as "Emery Flour consisting of five points emery, two pints clay, one pint plumbago, with or without soapstone or hard coal, all powdered and mixed."

No. 276,628 granted to J. F. Richards for a "Mold Facing," who describes his claims as follows: "About equal parts by weight of plumbago, wood-charcoal and bituminous coal are pulverized, sifted and mixed and enough common beer added to make a thin paste. Flour is then mixed in water until it has the consistency of cream. Three parts of the first are then mixed with one part of the second mixture and water added if desired. Applied with a brush in from one to three coats, according to circumstances."

(The reader should remember that these patents were granted more than seventeen years ago.—Ed.)

Patent No. 281,212 was granted to B. F. Watkins, whose claim is brief and reads: "A mold for casting steel, washed with an adhesive preparation of pure, finely pulverized silica."

W. J. Bausmith secured Patent No. 270,625 on a core compound composed of "200 pounds ground spruce-pine (or flour) 100 pounds kaolin (or loam sand), 20 pounds resin, 20 pounds coke, 15 pounds charcoal, 15 pounds ashes (preferably wood)." For brass two pounds of this compound are mixed with one bushel of core sand, but for iron the use of three pounds is recommended.

(And thus we see that there is nothing very new about core compounds, although we believe they have improved considerable of late.—Ed.)

Amon the patents and molding machines which have expired this year are those granted to J. North, No. 274,646; F. S. Hawkins, No. 270,898, and E. Thomas, No. 282,588.

S. Jarvis Adams patents No. 272,612 for method and apparatus used in making cores, and No. 274,691 for making molds, also expired some time ago. In the latter the flask is first rammed up with sand through a jarring mechanism and afterwards the pattern is forced into same through a rotating motion. The cores made by the first named patent completes the mold.

William Wilmington has four patents on methods for casting car wheels which expire during the current year. They are Nos. 273,658, 281,422, 289,741, 283,311. These have for their object the protection of the inventor in certain methods for casting car wheels which are supposed to modify the chill hardening qualities of the iron, forming the hub and plate portions of the wheel and prevent these parts from becoming too hard and rigid. As is well known, many attempts have been made to cast car wheels and other articles of different irons, something, by the way, which has never been successfully accomplished. Mr. Wilmington's patents be-

long to this class and we publish a short description of the author's claims for these more in a spirit to show what it is possible to patent in the metallurgical field than for any practical value they possess.

Mr. Wilmington said seventeen years ago, in applying for these patents, that he accomplished the objects for which the beforenamed patents were granted, by introducing into the mold granulated or powdered ferromanganese, spiegeleisen, or other compound containing large amounts of carbon, silicon or manganese so that it may be melted by the molten iron in the mold or pouring basin and become mixed with it. For each of the following processes (?) the inventor secured a patent: (1) Placing the ferro-manganese, etc., in the pouring basin after the mold is partly filled with iron and then pouring more iron upon it to carry it into the mold. (2) Causing the alloy (placed in the pouring basin as before) to flow into the mold by agitating the molten metal in the basin and keeping the pouring holes open by "churning." (3) Placing the alloy in the current of the molten metal after about three-quarters of the latter has been poured. (4) Coating certain parts of the mold with the powdered alloy before pouring.

It would certainly be worth the ordinary price of admission to a circus to see Mr. Wilmington "agitating" the metal, keeping the pouring holes open by churning, and getting a good car wheel at the same time.

The same inventor's patents Nos. 270,869 and 282,825, for a car wheel chill, also expire this year. J. N. Barr, another inventor of car wheel chills, has two patents lately expired, Nos. 279,520 and 288,969, the latter covering the claims for a contracting chill.

R. Brown's patent No. 289,499, for a foundry ladle gear, and, by the may, the only one of the Nesmith type ever patented in this country, expires Dec. 4.

A Cast Iron Man's Nightmare.

"Imperial Caesar, dead and turned to clay,
Might stop a hole, to keep the wind away."
—Shaks.

The world at large, if asked, would unite in the assertion that it would be impossible for anyone engaged in the line of work indicated by this heading, to have any imagination, yet they might admit the possibility of his having had, at times, dreams. Especially when his diet had been "bread and cheese" and k-k-k-kicks, especially cheese.

This idea has been forced on one cast iron man through the following: It became his duty one evening not long since, to visit the iron works about 10 p. m. It was a delightfully clear evening when our harvest moon was about at its full quarter. After attending to the duties that called him there, he gained a point overlooking the yard, where was stored the pig iron, coke, scrap, and other materials incident to his every-day work.

Whether he fell asleep, or simply thought thoughts, the writer cannot say; but for some reason his attention seems to have been absorbed by the "scrap pile."

On the surface, this was mainly composed of the wreck of a home of the past generation, which had been adorned by cast iron statues and statuettes of many mythical gods and goddesses, as well as some representing more modern statesmen, philosophers, poets, and artists.

At any rate, he conceived an idea (very rare for a cast iron man), and later was able to, in a measure, carry it out. And that was, that these cast iron representations should either fulfil their supposed destinies or contradict them in toto.

Therefore, Dante, of Inferno fame, became the chimney cap of a factory producing life-giving cereals.

Demosthenes, hunting for an honest man, was converted into a column for the grand stand of a race track.

Diana is the lintel over the entrance to a large manufacturing establishment, while Hebe is part of a cast iron drinking fountain for both man and beast.

Shakespeare does duty as a "snubbin' post" on the harbor dock, and Bacon is a foundation casting for a prominent pork-packing establishment.

Mendelssohn is appropriately a pillar in a music hall and Wagner is a truss casting in a boiler shop.

Voltaire has been melted over into Bible racks for passenger cars, and an old "store front" taken from a saloon of shady reputation is now the cast iron door sill for the Y. M. C. A. building.

Cases without number are cited by this imaginative cast iron man, but I weary you: still if this plain verbatim narrative will con-

vince the skeptical that the cast iron man does have an imagination, I am content.

C. I. MANN.

Deaths.

S. J. Grinnell, senior member of the foundry firm of Grinnell & Borland, of Newton Falls, Ohio, died at his home there Oct. 2, aged 48.

Thomas Marshall, a prominent foundryman of Pittsburg, Pa., died in that city September 24, seventy years old. Mr. Marshall was a native of Pittsburg, and started to learn the molder's trade when 15 years old. In early manhood he became associated with Harrison & Wyman, who had contracts from the Russian government for steel and ordnance, and he spent eight years in Russia. He was later in the foundry business under the firm names of Dickson & Marshall and Morris & Marshall, and in 1885 the Marshall Foundry & Structural Iron Works was founded, he being the directing manager.

Receipt for Making Litharge Oil Matches or Followboards.

Pulverized litharge.....3 parts
Boiled linseed oil.....7 parts
Steel or iron borings, sifted fine..1 part
Finely sifted gangway sand....89 parts

Mix the litharge steel borings and sand dry, care being taken to keep out all foreign matter such as molding sand, gravel or water. After thoroughly mixing add the oil and mix to the temper of ordinary molding sand.

In making litharge or oil followboards the frames should be made of common 1x1-inch pine or white wood and detached from pattern deep enough to admit one-half of pattern; patterns are bedded in flask of sand, the frame laid on, the composition then added, and the bottom board fastened down firmly with screws.

Many foundrymen make the mistake of nailing these boards to frame and then if desirous of using frame for another board they must destroy the bottom board to get the frame, while by using the screws the board can at any time be removed and frame used for another match.

In the constructions of these followboards, if the frame is built with the inside on a slight bevel, after followboard is dry, by turning the frame over after removing bottom board the center or followboard proper may easily be pressed out of frame.

Cupola Explosions.

In dropping a cupola bottom if the large mass of hot coke, slag, cinder and pieces of white-hot iron fall suddenly upon a wet base, an explosion is inevitable; and the danger and force of the explosion is greatly increased if there happen to be a considerable quantity of melted iron present.

Under no circumstances should the bottom be dropped until it is known that practically all the melted iron has been drawn out. Cinders will lie up loosely upon the sand base, and will not, except under extraordinary circumstances, cause an explosion. If a large mass of these, in a semi-plastic state, fall upon a wet base, and be forced down into it, an explosion is certain. But this does not often happen. Melted iron, however, will instantly find its way to the bottom and if this be wet, it will be heard from instantly.

It is not always possible to know whether there is molten iron in the cupola or not. There may be a depression somewhere in the sand bottom of the cupola, which will contain a considerable quantity of iron that will not run out at the tap hole. Again, the tap hole is sometimes so mismanaged as to raise it somewhat above the level of the bottom before the end of a heat. In this case the breast of the cupola ought to be entirely torn away in order to make sure of withdrawing all of the iron.

However, though it may be impossible to be certain that all of the melted iron is out, it is always possible to have a large body of dry sand under the cupola, and it is impossible that an explosion should occur where there is no moisture.

When one of these explosions occurs the man who is directly responsible for it is very glad to have all sorts of mysterious causes ascribed ,and when the true cause is named he will sometimes stoutly deny that there was any dampness under the cupola, and it is, of course, a very difficult matter to determine the case after the damage has been done.

From this fact some people are led to believe that somehow a peculiar and unusual combination of gases was at fault. So extremely improbable is this hypothesis that it

can have not the remotest claim to recognition except upon positive proof of the absence of moisture.

In short, if a good, deep bed of dry sand is under the cupola, and practically all the melted iron has been tapped out when the bottom is dropped, there will be no explosion.—E. H. Putnam in The Tradesman.

The Position of Cast Iron.

Will steel eventually replace cast iron to such an extent that our iron foundries must be remodeled, or have their production greatly curtailed? This question is at present confronting many a concern about to increase its capacity, or to branch out into the casting business. This condition of the market to-day, while keeping every foundry busy, makes the greatest demand upon the steel-casting trade. We know of a number of concerns which are far behind in deliveries simply because they cannot get their steel castings. The manager of one of the largest manufacturing corporations of the country recently made a special trip to see for himself what chances there were for getting work done at the various steel foundries of the East and middle West. He returned greatly discouraged with the prospect, and engaged to fill up any new enterprise which would do good work at short notice.

Naturally, this state of affairs means new steel foundries, and a review of the situation finds them springing up at new points, while the gray iron foundries are contenting themselves more by working overtime and cautious enlargement than by an aggressive campaign. From the standpoint of the present demands it would seem that in the coming struggle, when prices go back to normal figures, the steel casting will be found more formidable to the gray iron foundry than it was at the last period of prosperity. This in spite of the necessarily greater price of steel, due to the use of high-grade raw material and heavy losses due to process.

Is steel replacing cast iron as much as it is made to appear? Is the enormous demand for steel castings due to the removal of patterns from the iron foundries? More than likely the renewed activity of the country has enabled engineers to make use of an excellent material to a greater extent than ever before; and construction, which must be based upon light, strong and uniformly reliable products, will make cast steel invaluable. Cast iron, on the other hand, with its rigidity and comparative cheapness, is not pushed out so easily. Only where consumers have been taught to distrust it, where the requirements of the case have made steel and malleable castings better adapted in spite of the increased cost, has cast iron yielded to the inevitable; and gray iron foundries have tried, and are still trying, to keep this down to a minimum. The foundry should keep on making improvements, and thus be abreast of competing trades. Then let it come to the survival of the fittest.

A closer examination of the characteristics of the material may give us a fair idea as to the probable future of cast iron and cast steel. The former has a granular structure. The grains, so called, are all cushioned with graphite, easily separated from each other by a direct pull, but able to resist a tremendous crushing force without much deformation. Steel, on the other hand, is an aggregation of distinct crystals, the strong adhesive forces allowing a considerable flow of metal when a specimen is stretched, this also happening when it is crushed. Cast steel is especially valuable, therefore, when in tension, while cast iron is best adapted for compressive purposes.

From time immemorial cast iron has not given satisfaction when subjected to sudden and severe tensile strains; steel therefore took its place as soon as made reliable enough. The foundry business, however, has long ago adjusted itself to this requirement and has given up the gun though still keeping the mortar. On the other hand, we may go to-day into the rolling mills and ask there for the best roll for all around excellence, and we find not the steel, but the cast iron one recommended. Take an engine cylinder, whether it be as high as a small house or only for five horse-power; no one would think of casting it into steel. Here not only the rigidity, or lack of elasticity, but the fine-grained wearing surface make cast iron highly desirable. We question whether an engine frame would be made of steel were it as cheap as cast iron. And so all along the line we will find that whatever must be better than cast iron will leave the gray iron foundry, and that is no longer very

much; and where work has gone out in the belief that steel will give commensurate returns for increased cost, study and improvement of the gray iron used may often bring it back.

Why is it that Americans prefer cast iron car wheels, while in Europe they are still forging them out of iron and steel? Only because our methods of mixing and casting good irons are acknowledged to be far ahead of theirs, being brought about by the kind of competition which not only cheapens, but improves the product.

Is it not perhaps this fear on the part of the founder that cast steel may supersede his gray iron that has developed the important foundry movement now quietly but surely working out its destiny? Has not the need of more light on the constitution of that mysterious substance, cast iron, been forced upon the founder by this fear of the future? He wishes to arm himself for a possible struggle for existence; and surely with so many bright minds engaged in helping him, he should be in a position to overcome eventually every difficulty chargeable to defective foundry practice, and have his metal in that place in the industry where it rightly belongs. It will be his own fault if he does not keep it there.—Iron Trade Review.

Straight Castings.

To be thoroughly equipped for handling all the crooking castings that come to a jobbing foundry requires a clear understanding of the causes by which warps are produced and the several devices for correcting them; that is, it should be known beforehand what the crooks will be, and the proper treatment for each case. Straightening by bending the pattern in the sand in an opposite direction is one of the most simple methods and easy to understand, but it is only applicable to a very limited number of cases, such as long, slender lathe beds, where the pattern has only moderate stiffness to overcome.

One example of castings which may be kept straight by stripping is the lintel box, which is a good sample of crooking casting, and one easily treated, as it has the heavy side on top. I have handled very successfully all sizes up to 40 feet long and weighing nearly five tons. Although the long sizes have lately been largely superseded by the more reliable, made-up steel article, these still serve to illustrate one straightening treatment. A 12-foot lintel of this form would have a top plate, as molded, say 1¼ inches thickness, the sides ⅞ inch tapered down for draft to ½ inch at the bottom. Such a casting would cool very irregularly as to time. The top side, when the cope was removed, would be a bright red, while the thin edges at the bottom would be a very dull red, and the casting still straight. Such a combination, with irregular shrinkage to follow, would promise a crooked casting; that is, the top side, having the most shrinkage to occur, would become too short, and would be concave a half-inch or more, or contrary to mere shrinkage set. It presents a simple case. The metal has been distorted by shrinking irregularly under confinement, and the remedy lies in stretching the top side by stripping two or three sections near the middle, or about 5 feet or its length altogether. Cooling the top, if it cannot lift the ends, is a stretching process on the top plate. Weighting down the ends would be harmless in this case, and might be needed, as a lift of the ends would defeat the stretching of the top plate.

A case where heating kept the casting straight occurred with an 8-inch fluted building column 12 feet long, which, on account of the anchor plates being too thin, had sunk into the loam core, allowing the core to rise, promising a crooked casting. The top was stripped nearly bare and 100 pounds of dull melted iron poured, a little at a time, all over the top, then all was well covered with sand. On examining it later the color of top and bottom was found about equal, and the casting in the morning proved to be straight, a more valuable quality in a column than perfect equality of metal; and this treatment reduced the permanent shrinkage strain by insuring an equal time of cooling. With a stiff cast "barrel," the core, at the exact center, probably raised ¾ inch, leaving ½ inch on top and 1 inch on bottom, instead of ¾ inch all around.

There are a few cases of long, slender castings showing objectionable warping on account of unequal cooling, where the warping can be corrected very easily, and with more certainty than by any other process, through simply bending the flask in an opposite direction from that taken by the cast-

ing in warping. The bend should be made soon after pouring, or while the metal is still a high red, so that it will yield easily and receive the true set without fracture. My first experiment with this method was on stationary engine beds, the casting forming one side of a bed for 16 and 18-inch cylinders, with 4-foot stroke, and used quite extensively for driving Louisiana sugar mills. They were of the bold-paneled, ogee-molding style, 20 inches wide, 8 inches deep, and 22 feet long, and were cast with the face down, the inside being formed of green-sand cores hung in the cope with two screws in the wrought-iron core skeleton, the pattern being solid, With green-sand cores there will be considerable strain, a thickening at the bottom, which will increase the warp. These castings warped according to rule; that is, the ends sprung down 1¾ inches. Soon after pouring I set a heavy bar of iron under the bottom board, two or three feet from the end of the flask; then hooking on two sling hooks, hoisted the flask up until the end batten showed a lift of fully 1¾ inches from its bed. Plenty of large wedges were then driven under several of the battens for a firm support. The crane was then taken off and the other end of flask was treated in the same way. The flask in this case was of iron, but, being long and relatively slender, it bent under its weight with a very regular curve, producing a very true casting every way. These engine bed castings, thus treated, averaged between 36 and 50 a year for a long term of years, and not costing a cent for treatment, the device proved valuable.

These bed castings had formerly been straightened by the machinists, who fitted them, under the direction of a very incompetent manager, by reheating with a wood fire and weighting down. They blundered in many ways, and obtained an imperfect job in every attempt against repeated advice, in resting the casting on one center bearing, and in heating a very short section only, compelling a few inches of the length of it to stand an excessive amount of stretching, and almost invariably starting perceptible cracks, and kinking the top edges by excessive compression; that is, the top edge, as molded, but the bottom when straightened. There is no excuse for committing such violence on a few inches of length when we have 22 feet to act on, and worn-out flasks to slaughter. Besides, the longer the bend, the nearer the curved line is converted into a straight line.

Straightening by fire will be found to be one of the most delicate and difficult feats for the manipulator of castings. One of the most universal faults observed is the habit of piling on an excessive load of weight before heating, thus often cracking the casting before the highest heat is reached; the weight necessary is often surprisingly small. After witnessing many of those imperfect jobs, I volunteered to try one, and succeeded well in the following manner: The bed was placed on two bearings, about 4 feet apart and 4 inches high. A rough wall of fire-brick and double grate bars was made, 8 or 10 inches from the casting, to check the draft and the escape of heat, also to confine the fire closer to the casting. A strong wood fire was then applied to fully 5 feet of the middle of the casting. Gauge blocks were set under each end to bend the casting to, but they were not final, as they should be adjusted when the bend is made. The heating may have raised or lowered the ends, and then the bend given would be out to that amount. To prevent the long ends from settling too soon, when heated, a lever was placed under each end and a bar or plank to sustain one-third to one-half of the projecting weight until the time came to adjust the gauges and weight down. Such levers, carefully poised, will accommodate themselves to the heat bends, and not distort the casting beforehand.—R. D. Moore, in American Machinist.

An Old Firm.

Bloomington, Ind., claims the oldest manufacturing plant under one firm's name in Indiana. The Seward foundry was established here in 1821, and grandfather, father and grandsons have continued the business under the old firm name. The original firm (1821 to 1859) was composed of Austin Seward and his two sons, John and James. In 1859 John retired and William B. was taken in. Austin retired in 1897, leaving James and William B. In 1884 William H. Seward, son of William B., was made a partner. The death of James Seward left the business in the hands of William B. and son, William H., who now constitute the firm.

Cincinnati Foundries.

Cincinnati, from away back in the late fifties, has always been a considerable foundry center. In the early days before the steam railroad was a quantity in trade and commerce the contiguity of such a waterway as the Ohio river and its confluence with the Mississippi gave such cities as Pittsburg, Cincinnati, Louisville and St. Louis a very material advantage over inland towns. The south was not a factor in the iron industry of those days, and these river cities looked after its needs in that line. Cincinnati was a rival of Pittsburg in river marine work and the building of marine engines and steamboat work kept a considerable number of machinery and jobbing molders well employed.

In the sixties the stove trade had become a feature of Cincinnati's foundries, and during and after the war it flourished like a green bay tree. In 1866 it has been estimated that about 650 stove plate molders were employed in Cincinnati. Among the well-known names in the stove manufacturing industry of those days might be mentioned Resor & Co., Chamberlain & Co., The S. H. Burton Co., better known as Greenwood's, Redway & Burton, Adams & Peckover; and then crossing the river, for you are really still in Cincinnati, we have the Geo. W. Ball Co., The Wm. C. Davis Co., of Newport, and the I. Droege & Co., later known as Bogenschutz & Co., of Covington; and proceeding up the river a few miles the Nich. Patterson Foundry Co., of California, O. When river navigation gave way to the steam railroad, the river cities ceased to have an advantage, distances were eliminated to a degree and the stove trade slowly drifted away, following the markets westward and northward and distributing itself in the smaller towns of the State, which were then offering bonuses for the location of factories in their jurisdiction.

Cincinnati and vicinity is no longer a stove plate center, a small remnant now being all that is left of its former greatness. Resor & Co. is still in existence, but their really fine molding shop has of late been run with a small force for a few months each year, although better things are now looked for. Then there is the Goodwill on the site of the Adams & Peckover foundry, and within the last few months the Schulte Range Co. Across the river there is only the Star Foundry and Bogenschutz & Co. representing the stove trade.

Grate and mantle making was also a feature of Cincinnati's foundries in the sixties and seventies, and to old-timers the names of Innis & McGill, Hand, Innis & Whitehouse, and C. S. Rankin are still familiar. Other concerns embarked in the industry, but this, too, has recently dwindled away to almost nothing. Louisville has captured the greater portion of what is left to the trade in these markets, but ideas have changed in this kind of work as in nearly every other, and there is no longer the same demand for it.

Cincinnati has not ceased to be a foundry center, however. While these branches of the industry have left us, others have sprung up. It has ceased to be a stove-plate center, but it has developed into one of the greatest centers for the manufacture of wood-working and iron-making machinery in the country, and, if we include the Niles Tool Works, of Hamilton, O., this vicinity is said to be the greatest machine tool producing district in the world. The local manufacturers are no longer mere understudies of eastern machine tool builders, but are their equals, and some say superiors, both in design and output.

Including the U. S. Pipe & Foundry Co., situated at Addyston, O., there are about twenty-three jobbing and machinery foundries in Cincinnati and six in the neighboring cities across the river, including the two stove foundries which take in jobbing and furnace work. Some of this list are, of course, small foundries, but the greater number of them employ a fair force of molders.

The Hoefinghoff & Laue Co.'s foundry, located at Front and Lawrence streets, on the site of what was formerly the Niles Tool Works, and later the Wm. C. Davis Co.'s stove shop, is the most distinctively general jobbing shop of any in the city, although all are, properly speaking, general jobbing shops, but are largely engaged in making machine tool work in some of its forms, thus more nearly approaching the specialty shop. Hoefinghoff's, as it is commonly called, employs, as a rule, the largest force of molders of any in the city; between 80 and 90 has, during the past year, been about the average.

The Eureka Foundry on Richmond street is also a general jobbing foundry, although, like the others, it is largely engaged in making machine tool work. It is, perhaps, the best equipped of any in the city to handle large work. It has a steam crane of 25 tons capacity, and employs a force of journeymen molders that will average from 65 to 75 men. There are two cupolas with a possible joint capacity of about 80 tons. These are fitted with Hardert tuyeres, which will be referred to later in this sketch, and are highly commended by the management. As an example of the work that can be successfully handled in this shop, we are informed by the superintendent that they have an order now for two shear housings that will weigh about 23 tons each.

There are so many others that we must on this occasion pass them by with a simple mention. Among them are Thauwald's, Vulcan, Phoenix, Greenwald's, Globe, Jones & Bruce, Erhart's, Foley's, Lane & Bodley's, and others. Lane & Bodley confine themselves largely to engine building, and the I. & E. Greenwald Co. to engine and milling machinery work. Across the river we have the Western, Schuh & Martin, Newport Iron and Brass Foundry Co., Covington Foundry Co., and another shop of the U. S. Pipe & Foundry Co., the latter, as its name implies, and the shop of the same company in Addyston, O., being pipe shops with the usual jobbing foundries attached for making their fittings and specials. In making comparisons, if we include the pipe shops of the U. S. Pipe & Foundry Co., these are, of course, the largest foundries in this vicinity. Molders are not employed in making straight pipes, at least not molders in the sense in which we use the term.

As a rule, the foundries of Cincinnati are old shops, many of them, it is true, improved and patched up to accommodate them to changed conditions, but two—the Buckeye Foundry and the Queen City Foundry—are new foundries built to meet the necessities of rising young firms that found their old premises inadequate. Being new, their equipment is more up to date, they have better light and are better able to handle successfully their respective specialties.

The Queen City Foundry Co. is the oldest of these two, and is a reorganization of the old Queen City Foundry Co. The original foundry was on West Fifth street, just west of the C., H. & D. depot. At the outset the principal work was wood-working machinery and general jobbing with a sprinkling of grate and mantel and plumbers' supply work. Some time after the Laidlaw-Dunn Pump Co. was organized and the Queen City Co. secured their foundry work, which amounted then to about one ton of castings per day. About eighteen molders was the average staff of the old foundry and the melt about six tons. As time went on the Queen City foundry gradually began to drop out from the machine tool trade and devoted its attention to pump and a better class of machinery work. It became evident that the old plant was not adequate for the larger class of work it was called upon to do, and a site was chosen for a new brick foundry at the corner of Spring Grove and Alabama avenues. On August 8th, 1899, the first heat was run off in the new shop. One continuous stretch of side windows and skylights furnish excellent light, the roof is high and excellent provision made for ventilation. The molding room is 91 feet by 182 feet, the core room and ovens being in an off-shoot building about the center of the shop, while the cleaning and mill rooms are at the end, thus keeping the foundry free from the clatter and dust of these useful but annoying adjuncts. The floor space is completely covered with traveling cranes. On the main run, down the center of the shop, there are at present three travelers of respectively 5, 7 and 8 tons capacity, with a fourth one of 16 tons capacity ordered to be put up as soon as possible. On the sides there are four 5-ton travelers. The shop is fitted with electric lights throughout and supplied from their own dynamo. The cupola is a Whiting fitted with a Root blower and having a capacity of about 10 tons an hour. On an average from 30 to 40 molders are employed, nearly all on a heavy class of good pump work, together with gas engine and hydraulic press work, which requires the highest degree of mechanical skill both from the molder and the coremaker. The average output is 300 tons of clean castings monthly.

In front of the foundry building, facing Spring Grove avenue, is a three-story brick building, 40x100 feet. On the first floor are the office rooms, carpenter shop, and pattern room, while the two floors above are

used as pattern store rooms. In the yard we find an elevator operated by steam power for hoisting the charges for the cupola and a 50-foot jib fitted to do service as a crane or as a drop, also operated by steam power. Altogether, it is a founndry of which the proprietors may be justly proud and will compare favorably with any foundry of its kind in the country.

Like the Queen City, the present is not the original Buckeye Foundry. The old shop was on Central avenue, and is now the Vulcan Foundry. The company was originally a sort of co-operative concern organized in 1888, and started in as a general jobbing shop, an average of from 25 to 40 molders being employed. The young concern had a rough road to travel for a time and the partners had to work like beavers to make headway. They got there, however, and being far-sighted enough to realize that Cincinnati was fated to be a great machine tool producing center, they gradually drifted into that class of work as a specialty. In 1896 the new shop was built, and this is also located in the west end of the city, on Buck street, just a stone's throw from Thauwald's foundry and works. In the new shop everything was adapted to the needs of their specialty, which includes lathe, milling machine, radial drill and shaper work, of which about 400 tons of clean castings are turned out monthly. Lathes ranging from the smallest size to the 30-footer, 28-inch swing, are here turned out, and facilities for their making furnished the molder which have been designed with a view to minimizing his labor and making it most productive. Instead of the wooden flasks with barred cheeks, which were eternally being burnt out and replaced, wrought angle iron flasks are used, the cheeks of which are fitted with cast iron grids to carry the sand and minimize "gaggering." Cone pulleys and head stocks are made without copes, while there are no fewer than nine travelers overhead, so that there will be no undue delay through waiting for the crane. Of these cranes there are four in the main or central run, 2 of 10 tons and 2 of 5 tons capacity and on the sides 3 of 3 tons and 2 of 2 tons. The provisions for lighting and ventilation are good, the shop is furnished with electric lights and steam heat throughout. The main shop is 90x180 feet and a later addtion 45x90 feet. The average molding force is from 50 to 65 journeymen. The cupola is a Whiting fitted with tuyeres designed by their former cupola man, which have proven such a success that he has quit cupola tending to push their introduction. They are known as the Hardert tuyeres, and Mr. Charles Lange, of the Buckeye Foundry Co., is sponsor for the statement that they enable them to charge with a ratio of 120 lbs. coke to 2,000 lbs. iron and, including the bed, in an ordinary heat to melt with a ratio of about 1 to 14. These tuyeres are used in several other foundries in the city. In the yard we find a hydraulic elevator with automatic pump for hoisting pig iron and fuel to a scaffold built of iron and steel to minimize the danger from fire. A large area of the yard is roofed in to furnish protection from inclemency of weather.

Forming the cross part of a T to the foundry is a two-story and basement brick building, 36x100 feet, facing on Buck street. In this are the office apartments, cleaning and shipping rooms, and a well-equipped pattern and carpenter shop, the former being an adjunct for the greater convenience of customers desiring changes to be made, while overhead are the pattern store rooms. With this description we dismiss the Buckeye Foundry and leave it to our readers to give credit where credit is due.

In such a sketch as this, covering, as we have attempted, so much ground, it has been impossible to give as much notice to each foundry of the city as we would have liked, but enough has been said to enable the reader to form a fair estimate of Cincinnati and its foundries, and that was our design. —Iron Molders' Journal.

Fires.

E. S. Chatfield's foundry, at Addison, N. Y., burned Oct. 6.

Perry & Co.'s stove foundry, at Salem, Ore., was burned Sept. 26.

The foundry of Chas. P. Maxwell & Son, at Lisbon Falls, Me., burned recently.

Robert Whitelaw's foundry, at Woodstock, Ont., was greatly damaged by fire Sept. 18.

The Iowa Mfg. Co., of Oskaloosa, Iowa, lost a number of valuable patterns in a fire Oct. 7.

The Stroh-McIntosh foundry, at Barberton,

Ohio, burned Sept. 11. Loss, $6,000. It will be rebuilt.

The plant of the Frew Machine Co., at Rockhill, S. C., was totally destroyed by a recent blaze.

The Wm. Bayley & Sons Co., of Milwaukee, Wis., lost a number of valuable patterns and tools in a fire Sept. 29.

Pattin Bros. & Co., of Marietta, O., had their foundry and machine shop burned to the ground a short time ago, entailing a loss estimated at $15,000.

Among the Foundries.

Hildreth & Co. will enlarge their plant at Lansing, Mich.

Clarence Simpson will start a foundry at Bellaire, Ohio.

Walter S. Bosworth is building a foundry at Warren, R. I.

Bishop & Co. are building a foundry and machine shop at Ballard, Wash.

The foundry of the Twin City Iron Works, at Hurley, Wis., is being enlarged.

Philo B. Clark will add a foundry to his machine shop at Rumford Falls, Me.

The Knoxville (Tenn.) Foundry & Machine Co. will build an addition to its plant.

Jackson, Cochrane & Co., of Berlin, Ont., will increase the capacity of their foundry.

The Tioga Foundry Co., of Philadelphia, Pa., will build a large addition to its plant.

The Brown Cotton Gin Co., of New London, Conn., will build an addition to its foundry.

The Tyrone (Pa.) Foundry and Machine Co. has been incorporated with a capital of $25,000.

The National Sewing Machine Co., of Belvidere, Ill., is building a new foundry 500x90 feet.

The Bowler Foundry Co. has been incorporated at Cleveland, O., with a capital of $50,000.

The George H. Holliday Foundry Co ,is a new concern doing business at New Richmond, Ohio.

The Acme Brass Works, of Elkhart, Ind., is a new concern making brass castings at that point.

The South Bend (Ind.) Foundry Co. is building a new foundry to replace one recently burned.

The R. Stoever Foundry & Mfg. Co. has been incorporated at Myerstown, Pa., with a capital of $30,000.

The Mississippi Foundry & Machine Co. has been incorporated at Jackson, Miss., with a capital of $10,000.

The South Halstead Street Iron Works, of Chicago, has increased its capital stock from $50,000 to $100,000.

George Grove has started the old Yephart foundry at Cumberland, Md., into operation after a lengthy idleness.

It is reported that the City Iron Foundry Co., of Woonsocket, R. I., will remove their plant to Pawtucket, R. I.

Press reports state that the Tallapoosa Oil Co. expects to erect a foundry and machine shop at Alexander City, Ala.

It is reported that the Canadian General Electric Co. has purchased the plant of the Canada Foundry Co. at Toronto, Ont.

Perham & Stickney's foundry, formerly the foundry of the Atherton Machine Co., at Lowell, Mass., has started up after a long idleness.

The Long Foundry Co. has been incorporated at Rochester, N. Y., with a capital of $50,000 by James S. Graham, John Kane and John Long.

J. K. Kuhn has secured control of the Chickamauga foundry at Chattanooga, Tenn., and will place same in operation. It has been idle for more than a year.

Alex. W. McLean, late master mechanic of the Ashland division shops of the Chicago & North-Western Railroad, has purchased the Kaukauna (Wis.) Machine Works of William Liebert.

N. H. Pine is rebuilding his foundry at Eureka, Cal., burned some time ago. He has also purchased the Humboldt Iron Works from George Watson and will temporarily occupy the latter plant.

J. P. Raymond, of Oswego, N. Y., has leased the foundry of A. G. Heath, at Adams, N. Y., for a term of two years with the privilege of five. He intends to make improvements and materially increase the business.

George R. Dean has designed for the Goodman Manufacturing Company a one and two-story foundry and machine shop, to be built at Halsted and Forty-ninth streets, Chicago. It will extend over 250x100 feet, and will be of brick and stone, at a cost of $30,000.

A number of additions and improvements

are being made to the plant of the Frank-Kneeland Machine Company, Pittsburg, Pa. A new pattern storage warehouse, 78x150 feet and three stories high, will be built out to the harbor line of the Allegheny river. A large addition will also be made to the foundry of the plant. This will be 50x120 feet, and will be supported on the river side by five piers 40 feet in hight. The company are extensive builders of rolling mill machinery and rolls.

The Mesta Machine Company, Pittsburg, is now operating its large new plant at West Homestead, Pa., in full. The whole plant is contained in one building, 820 feet long and 250 feet wide. This contains the open-hearth steel furnaces, cupolas, air furnaces, the molding departments, machine shop and erecting shop, the product being ingot molds, iron and steel rolls, sand and chilled, machine molded gears of steel or iron, and rolling mill and tin plate machinery. The different departments are running full, with the machine shop on double turn. Two 50-ton electric overhead traveling cranes have just been installed, making fifteen overhead cranes in all in the plant. The design of the plant has been found in actual operation to be very satisfactory.

General Jacob S. Coxey, who six years ago marched at the head of an army of several hundred unemployed workingmen into the national capital, Washington, D. C., and camped on the lawns surrounding the White House, is to-day advertising for men to work on the immense steel casting plant which he is now erecting in Mount Vernon, O., says the Chicago Tribune. Mr. Coxey is personally superintending the construction of the plant. He has made a great deal of money out of his wonderful silica sand quarries near Massillon, O., within the last two years, or ever since the great revival of the steel casting business. He owns the quarries from which the sand used by the Carnegie and other great steel casting companies is secured. Mr. Coxey some time ago came to the conclusion that, having sand, he might as well make the castings. In April he decided to locate his plant in Mount Vernon, and purchased an enormous tract of land there. In May the ground was broken for one of the finest steel casting plants in the country, and ever since he has been hard at work with all the men he could secure pushing the plant to completion. The walls of the main building, which is 175x515 feet, are nearing completion. Another building of 165x65 feet is ready for the roof, and the foundations are being laid for a power house and gas plant 36x174 feet in size. Two open-hearth furnaces, one of fifteen and one of twenty-five tons' capacity, are being constructed. There will be eight electric traveling cranes, one of fifty, one of thirty, two of fifteen, and four of five tons' capacity.

For Your Leisure Hours.

In casting three wheels, 48 inches in diameter and 12-inch face, one has a rim 1 inch thick, the second is 6 inches and the third 18 inches thick. Will there be a greater strain on the heavier ones, provided all other conditions are equal?

INQUIRER.

Some Pointed Pointers on Foundry Practice.

In a catalogue, describing the Weiss molding machine, recently issued by the Maywood Foundry & Machine Co., of Maywood, Ill., the following paragraphs are addressed to those who mix iron by chemical analysis:

That castings are affected by five elements associated with the iron.

That these elements are carbon, silicon, manganese, phosphorus and sulphur.

That carbon is contained in iron in two forms—combined and graphitic or free carbon.

That the total carbon usually held by iron is 3½ to 4½ per cent.

That in light work the proportion of combined to graphitic carbon should be about one in ten.

That if graphitic carbon predominates excessively, large castings lose strength.

That combined carbon adds strength and hardness to castings.

That the ability of carbon to combine with iron is affected by silicon and manganese, also slightly by sulphur.

That silicon up to 3 per cent. softens iron by keeping the carbon in the graphitic state.

That excessive silicon decreases strength and produces brittleness.

That strongest castings are made from iron which will produce sound castings with the least amount of silicon.

That about 0.20 per cent. of silicon will be lost in remelting.

That manganese produces hardness and shrinkage, acting direct upon the iron.

That manganese acts to maintain the carbon in iron in the combined state.

That manganese removes sulphur from iron.

That considerable manganese escapes in the slag during melting in cupola.

That phosphorus weakens iron by producing "cold-short."

That phosphorus prolongs the fluidity of iron, and is therefore good for light, thin castings.

That phosphorus reduces shrinkage.

That phosphorus should never exceed 1 per cent., and is not lost in melting.

That sulphur is the foundryman's worst enemy.

That sulphur produces "red-short," and makes iron hard and white by causing it to retain its carbon as combined.

That sulphur makes iron sluggish and gives rise to blow-holes during solidification.

That "red-shortness" caused by sulphur may be largely counteracted by manganese.

That sulphur is removed only to a limited extent by silicon.

That lime or fluor spar removes sulphur from iron.

That sulphur should never exceed 0.10 per cent. in castings.

Foundry pig should analyze about as follows:

	No. 1	No. 2	No. 3
Graphitic carbon	3.54	3.01	2.50
Combined carbon	.14	.28	.75
Silicon	2.80	2.55	1.95
Manganese	.30	.40	.55
Phosphorus	.75	.70	.30
Sulphur	.01	.02	.02

In using machinery scrap it is difficult, of course, to form any estimate as to how it would analyze, although on the average it will run about 2.95 per cent. graphitic carbon, 0.50 per cent. combined carbon, and about 1.55 per cent. silicon. Stove-plate scrap usually runs about 2.75 per cent. silicon, 0.95 per cent. combined carbon, and will be low in manganese and high in sulphur.

The following mixture has been found very satisfactory for light castings:

Graphitic carbon	3.120
Combined carbon	.350
Silicon	3.200
Manganese	.450
Phosphorus	1.000
Sulphur	.080

The volume of blast required to melt a ton of iron in the cupola (i. e., for 250 pounds of coke), is about 25,000 to 30,000 cubic feet; and ordinarily the most economical pressure will be about twelve ounces.

Notes From Various Sources.

Stevenson, Field & Co., of St. Louis, Mo., announce that through special arrangement with the Sloss-Sheffield Steel & Iron Co. they have been appointed exclusive selling agents in that territory for this company's product.

Examiners in the U. S. Patent office at Washington, D. C., depend to a considerable extent upon trade journals and manufacturers' catalogues to keep them posted upon appliances in common use. A recent issue of the "Official Gazette" contains the following notice:

"This office would be pleased to receive from manufacturers and publishers such catalogues, circulars, price lists, or other advertisements relating to the sciences and mechanical arts as are published by them for gratuitous distribution; but notice is hereby given such manufacturers or dealers who feel disposed to send their publications that not less than three copies should be forwarded in order that the subjects may be properly indexed, classified, and subclassified in the Scientific Library for convenient and ready reference."

The new shipbuilding plant for the Risdon Iron Works, at San Francisco, Cal., will be built by the American Bridge Company, of New York, and will consist of a boiler shop, machine shop and foundry, all of the latest and most modern description.

The Diamond Machine Co., of Providence, R. I., have issued a new catalogue of grinding machinery. Copies of same may be had upon application.

The American Bridge Company announce that Mr. August Ziesing has been appointed as the general western representative of the company, with headquarters at Chicago, Ill.

The annual returns of the State Bureau of Industrial Statistics shows that Pennsylvania, during 1899, produced 6,542,998 tons of pig iron, the value of which was nearly $100,000,000. An average of 15,347 workmen were employed in making pig iron during the year and the average yearly earnings of skilled and unskilled labor was $495.18. The pig iron production of the State during 1899 was greater than any previous year in its history.